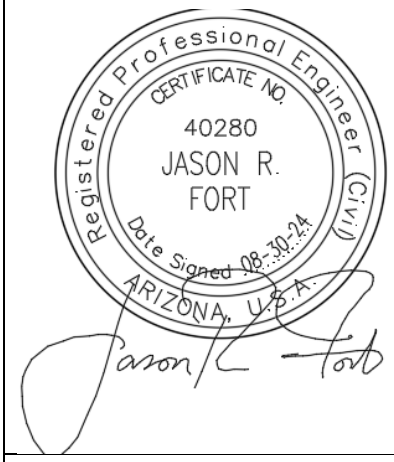
SEALS AND SIGNATURES

Owner Name: City of Phoenix
Facility or Site Name: Lift Station 40
Project Name: Lift Station 40 Refurbishment
Project No: WS90400085
Engineering Firm: HDR Engineering, Inc.

This book of specifications and related Contract Documents represent the efforts of the following registered design professionals:

	I hereby certify that the portion of the Specifications described below was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Arizona. JASON FORT 8/30/2024 Pages or Specifications divisions or sections covered by this seal: Div. 01, Div. 02, Div. 10 (10 14 00), Div. 11, Div. 22, Div. 31, Div. 32, Div 33 (33 05 05 to 33 14 10), Div. 40 (40 05 05 to 40 05 73.25, 40 10 15, and 40 46 16), Div. 43, Div. 44, and Div 46.
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SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.1 LOCATION AND DESCRIPTION OF WORK

A. The Work is located on the site of the Lift Station (LS) 40 at Ray Road and I-10 , in Phoenix, Arizona.

B. The Contract Documents include the following:
- Volume 1 of 3 Division 0 to 1 Specifications
- Volume 2 of 3 Divisions 1 Through 46 Specifications
- Volume 3 of 3 Drawings

C. The Work to be performed includes the following, but is not limited to:
1. Construction of LS 40 including the construction of a new wet well, pig launching structures, electrical building, generator, ferrous chloride storage, biofilter, and other work in the area located north of the existing lift station as shown in the Contract Drawings.
2. Installation, maintenance, and operation of temporary generators and temporary power distribution equipment as needed to provide uninterrupted service during construction of LS 40.
3. Installation, maintenance, and operation of temporary pumps and force mains to provide uninterrupted service during construction of LS 40.
4. Installation and maintenance of temporary power supply, odor control and ferrous chloride supply as needed during construction.
5. Relocation of existing utilities and new utilities as shown in the Contract Drawings.
6. Cleaning, demolition, disposal, and abandonment of existing structures, equipment (including fuels, oils, grease, refrigerants, etc) and utilities as shown in the Contract Drawings.

D. Hazardous Environmental Condition: The responsibility for cleaning and disposal of Hazardous Environmental Conditions, including but not limited to, existing Ferrous Chloride supply and storage system, Bioxide supply and storage systems, sewage conveyance systems, and other items shown in the Contract Drawings, is within the Scope of Work, belongs to CONTRACTOR and shall be coordinated with the General Conditions, Supplementary Conditions and Section 01 66 13, CONTRACTOR'S Hazardous Materials Management Program.

1.2 CONTRACT

A. The Work shall be constructed under one prime contract.

1.3 OTHER CONSTRUCTION CONTRACTS

A. NOT USED

1.4 WORK BY OWNER

A. OWNER will perform the following work:
   1. Operation of all existing system gates, valves and equipment, unless specified otherwise.
   2. Assistance and support during start-up and commissioning.

1.5 OWNER-FURNISHED EQUIPMENT AND MATERIALS

A. NOT USED

1.6 ASSIGNED PROCUREMENT CONTRACTS

A. NOT USED

1.7 SEQUENCE AND PROGRESS OF WORK

A. Submit a Construction Schedule covering the entire Work in accordance with Section 01 32 16.15, Construction Progress Schedule.

B. Incorporate the requirements of Section 01 32 16, Construction Progress Schedule, and Section 01 14 16, Coordination With OWNER'S Operations, into the Construction Schedule. CONTRACTOR'S construction schedule may use a different sequence from that shown or specified, if techniques and methods known will result in cost and time savings to the OWNER and still achieve the required objective and maintain the same or greater level of treatment or operation. The ENGINEER'S determination on the acceptability of any alternative sequence from that shown or specified shall be final.

C. CONTRACTOR: Make provisions in sequence and progress of Work to account for longer manufacturing and delivery lead times for pumps, motors electrical equipment, and other equipment specified under this project.

D. Following is a preliminary phasing of construction. Contractor shall submit detailed phasing to the OWNER and ENGINEER for approval.

   1. Construct new Pig Launching Structures No. 2 and No. 3. Install and connect temporary bypass piping from existing Force Mains No. 2 and No. 3 inside the existing vault to the above ground new Pig Launching Structures as shown in the Contract Drawings. Existing Force Main No. 1 shall remain in service. Minimum of two force mains shall remain in operation at all times.
   2. Construct new wet well, install pumps, discharge piping and appurtenances. Construction new Force Mains No. 2 and No. 3. Construct new Force Main No. 1 towards proximity of existing 27-inch gravity sewer.
   3. Construct new 42-inch gravity sewer line from wet well through MH No. 2 past all electrical duct bank work for new electrical building. Install temporary plug on upstream invert of MH No. 2.
   4. Construct new 42” gravity sewer line from wet well towards proximity of MH

No. 3.

5. Install new force main header, valves, fittings, and biofilter.
6. Construct electrical building and perform startup and commissioning of new Lift Station 40.
7. Construct new chemical injection piping from injection points to existing chemical injection system. Make temporary connection to existing chemical inject system.
8. Install temporary pumping bypass from existing MH No. 402 to new wet well as shown in the Contract Drawings.
9. Install temporary pumping bypass from existing MH No. 419 to new MH No. 2 as shown in the Contract Drawings.
10. Decommission existing LS 40. Demolish and abandon existing LS 40 structures and utilities as shown in the Contract Drawings to complete the 42” gravity sewer from past electrical duct bank work to new MH No.1. Connect new MH No. 1 to existing 36” gravity sewer. Remove associated pumping bypass.
11. Construct new MH No. 4 and connect to new 42” gravity sewer and existing 27” gravity sewer. Remove associated pumping bypass.
12. Construct new Force Main No. 1 and Pig Launching Structure No. 1.
13. Continue demolition and abandonment of existing LS 40 structures and utilities as shown in the Contract Drawings.
14. Construct new Ferrous Chloride Storage area and connect to new LS 40.
15. Remove and demolish existing chemical injection piping system and storage.

1.8 CONTRACTOR'S USE OF PREMISES

A. Coordinate use of the premises, for his storage and the operations of his workmen, with OWNER, ENGINEER and utility service companies.

B. CONTRACTOR shall coordinate with OWNER for identifying and obtaining approval of a laydown area. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to CONTRACTOR. CONTRACTOR must operate entirely within the space allowed to him.

C. Sole responsibility for obtaining and paying all costs in connection with any additional work area, storage sites, access to the site or temporary right-of-way which may be required for proper completion of the Work, belongs to CONTRACTOR.

D. It shall be understood that responsibility for protection and safe-keeping of equipment and materials on or near the site will be entirely that of CONTRACTOR and that no claim shall be made against the OWNER or his authorized representatives by reason of any act. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the ENGINEER shall direct CONTRACTOR owning or responsible for the stored materials and equipment to immediately move the same. No materials or equipment may be placed upon the property of the OWNER, other than in the designated areas as shown on the Drawings, or as described in the specifications, unless the ENGINEER has agreed to the location contemplated by

CONTRACTOR to be used for storage. All stored materials shall be labeled according to the appropriate contractor or subcontractor with the manufacturer's label as well. Appropriate material safety data sheets (e.g., MSDS) shall be provided.

E. Required to share use of the premises with other contractors whose services the OWNER has obtained or will obtain for construction of other facilities on the site.

1.9 EASEMENTS AND RIGHTS-OF-WAY

A. Easements and rights-of-way determined by the OWNER to be required to perform the Work will be provided by OWNER. Confine construction operations within the limits indicated on the Drawings. Use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies in order to avoid damage to property and interference with traffic. Do not enter any private property outside the designated construction easement boundaries without written permission from the ENGINEER and the owner of the property. Any private property or rights-of-way owned by other than the OWNER, which CONTRACTOR wishes to utilize during the performance of the Work, shall be provided by CONTRACTOR.

B. Within Highway Rights-of-Way: Permits will be obtained by CONTRACTOR. All Work performed and all operations of CONTRACTOR, its employees, or subcontractors within the limits highway rights-of-way shall conform to the requirements and be under the control of the highway authority owning, or having jurisdiction over and control of, the right-of-way.

1.10 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

A. Notify owners of adjacent properties and utilities when prosecution of the Work may affect them.

B. When it is necessary to temporarily obstruct access to property, or when any utility service connection must be interrupted, give notices sufficiently in advance to enable the affected persons to provide for their needs. Conform notices to any applicable local ordinance and, whether delivered orally or in writing, include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Utilities and other concerned agencies shall be coordinated well in advance of scheduled work. Notification to utilities and other concerned agencies shall be made at least 48 hours prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines.

1.11 SALVAGE OF EQUIPMENT AND MATERIALS

A. Existing equipment and materials removed, and not shown or specified to be reused as a part of the Work, shall become CONTRACTOR’S property.

B. Existing equipment and materials removed by CONTRACTOR shall not be reused in the Work, except where so specified or indicated.

C. Carefully remove, in a manner to prevent damage, all equipment and materials specified or indicated to be salvaged and reused or to remain the property of OWNER. Store and protect salvaged items specified or indicated to be reused in the Work. Replace in kind or with new items any items damaged in removal, storage, or handling through carelessness or improper procedures.

D. Furnish and install new items, with ENGINEER'S approval, instead of those specified by OWNER or indicated to be salvaged and reused, in which case such removed items will become CONTRACTOR'S property.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 01 11 11

PARTNERING

PART 1 - GENERAL

1.1 COVENANT OF GOOD FAITH AND FAIR DEALING

A. Scope:
   1. The Work imposes an obligation of good faith and fair dealing in its performance and enforcement.
   2. CONTRACTOR, ENGINEER and OWNER, with a positive commitment to honesty and integrity, agree to the following mutual duties:
      a. Each will function within the laws and statues applicable to their duties and responsibilities.
      b. Each will assist in the other's performance.
      c. Each will avoid hindering the other's performance.
      d. Each will proceed to fulfill its obligations diligently.
      e. Each will cooperate in the common endeavor of the Work.

1.2 VOLUNTARY PARTNERING

A. OWNER intends to encourage the foundation of a cohesive partnership with the ENGINEER and CONTRACTOR and its principal subcontractors and suppliers. This partnership will be structured to draw on the strengths of each organization to identify and achieve reciprocal goals. The objectives are effective and efficient contract performance and completion within budget, on schedule, and in accordance with the Contract Documents.

B. This partnership will be bilateral in makeup, and participation will be totally voluntary. All costs associated with effecting this partnering will be agreed to by the OWNER, ENGINEER and CONTRACTOR and will be shared equally.

C. To implement this partnering initiative prior to starting of Work in accordance with the requirements of Section 01 11 00, Summary of Work, and prior to the Pre-construction Conference, CONTRACTOR'S management personnel and the OWNER will initiate a partnering development seminar/team building workshop. The ENGINEER will make arrangements to determine attendees at the workshop, agenda of the workshop, duration, and location. Persons required to be in attendance will be the OWNER, ENGINEER, and key project personnel, CONTRACTOR'S on-site Project Manager and other key project supervision personnel of both the principal subcontractors and suppliers. During the workshop, the participants shall develop and sign the Project Partnership Charter.

D. Follow-up workshops may be held periodically throughout the duration of the Work as agreed by CONTRACTOR, ENGINEER and OWNER.

E. The establishment of the Project Partnership Charter will not change the legal relationship of the parties to the Work nor relieve either party from any of the terms of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 01 11 12
TEMPORARY BYPASS PUMPING AND PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for furnishing materials, labor, equipment, power, fuel, maintenance, piping, valves, pipe plugs, pipe specials and appurtenances necessary to implement temporary bypass pumping and piping systems as required to complete the Work.

B. The design, installation and operation of the temporary bypass pumping and piping systems shall be the Contractor's responsibility. The Contractor shall engage the services of a bypass pumping and piping subcontractor for the temporary bypass pumping and piping requirements. The subcontractor shall have the skill, knowledge and expertise in the design and operation of temporary bypass pumping systems. The subcontractor, through the General Contractor, shall be fully responsible for maintaining the temporary pumping system and keeping it fully and reliably operational during the entire temporary bypass pumping period.

C. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 01 14 16 - Coordination with Owner's Operations.

1.2 QUALIFICATIONS

A. The bypass pumping subcontractor, through the Contractor, shall demonstrate expertise in temporary bypass pumping and piping systems by submitting a list of at least five references of projects of a similar size and complexity as this project performed within the past five years.

B. The bypass pumping and piping system shall meet the requirements of all national and local codes and regulatory agencies having jurisdiction.

1.3 SUBMITTALS

A. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Submit bypass pumping and piping plan, see Drawings and Section 01 14 16 Coordination with Owner's Operation.

C. Documentation of Experience/Qualifications.

D. Shop Drawings:
   1. Detailed drawings and descriptions outlining the details and provisions for the temporary bypass pumping and piping system are required. The submittal shall be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials and other incidental items necessary and/or required to ensure proper operation of the bypass pumping systems, including compliance with permit conditions. No bypass pumping or piping shall begin until all provisions and requirements have been reviewed and accepted.
   2. Availability and location of replacement pumps of equal size to that specified herein that could be used in the event of a bypass pump failure.
   3. As a minimum, the bypass pumping plan shall include the following:

a. Sequence of Proposed Work Activities in accordance with Bypass Pumping Plan. Sequence shall consider the following requirements.
    1) Bypass pumping plan shall follow Contract Drawings. Provide temporary bypass pumps as required to supplement bypass activities.
        a) Bypass valves are proposed on the existing force mains to keep the existing lift station to be in service while work is completed to construction the new wet well, pumps, piping, etc. as shown in the Contract Drawings.
    2) Complete shutdown of the lift station operations (permanent and bypass pumping) is not acceptable. A scheduled shutdown shall only occur when there is no predicted event in the weather forecast during and approved by Owner at a minimum of two weeks in advance of the Work.
    3) Select Work Activities shall only be completed as identified in the Contract Drawings.
b. Staging areas for pumps.
c. Flow stoppage system, including pipe/channel plugging method and types of plugs.
d. Number, size, material, location and method of installation of pump suction piping.
e. Number, size, materials, method of installation and location of installation of discharge piping.
f. Size and location of standby power generator, if required.
g. Downstream discharge plan.
h. Method of protecting discharge structure from erosion and damage.
i. Thrust and restraint block sizes and locations.
j. Temporary pipe supports and anchoring required.
k. Hydraulic calculations of static lift, friction losses, and flow velocity.
l. Procedure for when the remote auto-dialer is activated by events specified herein.
    1) Contact information for the Contractor and Subcontractor that is programmed into the auto-dialer.
m. Locations requiring temporary fencing.
n. Spill response plan.
o. Method of noise control.
p. Standby power generator size and location.

4. Product technical data:
    a. Number of pumps.
    b. Bypass pump sizes and capacity.
    c. Power requirements.
    d. Pump curves.
5. System curves with the proposed pipe size alignment. Contractor shall be responsible for determining the minimum and maximum suction water levels to avoid NPSH concerns with the selected pumps, as well as to avoid sanitary sewer overflows upstream of the pumping operation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Firms are acceptable:
   1. Capital Pump and Equipment
   2. United Rentals
   3. Rain for Rent
   4. Approved Equal.

2.2 COMPONENTS

A. General:
   1. Provide bypass pumping and piping as specified within and where shown on Drawings.
   2. Firm pumping capacity is defined as actual pumping units installed and operational. Redundant pumping capacity is defined as actual pumping units installed, including all suction and discharge piping, controls and power source, but not in actual operation. One redundant pump equal in sized to the largest pumping unit provided shall be on-site and ready for immediate operation and use in the event of an emergency or breakdown.
      a. Operation of the redundant pumping system shall occur automatically in the event a portion of the firm pumping capacity system fails. The Contractor shall be notified immediately via the remote auto-dialer during this situation.
      b. In the event the firm pumping capacity system fails and the redundant pumping system is operational, replacement of the failed bypass pumping components shall be on-site and operational within 48 HRS of the failure in order to maintain 100 percent redundant pumping capacity.
   3. The Contractor shall be responsible for cleanup, fines, or other penalties resulting from spills during bypass operation.
   4. Structures normally sealed that are required to be open for the bypass pumping operation shall be temporarily sealed with cut-outs for suction and/or discharge piping.
   5. The bypass pumping systems shall be designed to operate continuously.
   6. Select pumping/bypassing equipment that will not have excessive noise levels from pumping/bypassing equipment and shall be restricted to a maximum of seventy decibels (70 db) at a distance of 50 FT or as required to be in compliance with jurisdictional specific noise ordinances.

B. Temporary and Bypass Pumps:
   1. Fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system.
   2. Provide sound attenuated enclosure per pump. Maximum of seventy decibels (70 db) at a distance of 50 FT is required.
   3. Constructed to allow dry running for extended periods of time to accommodate the cyclical nature of lift station and pipeline flows.
   4. A pressure gage shall be provided on the pump discharge.
   5. The Contractor shall provide alarms during bypass operations. Bypass operations need alarms to contact Contractor as the primary responder and responsible operator.
   6. Temporary Bypass Pumping shall meet the following requirements:
      a. Bypass existing force main sections as shown in the Contract Drawings and connect to new Pig Launching Structures. Refer to Bypass plan for number and location of bypass and isolation valves (Bypass Plan Sheet 1

of 3). No temporary pumping is required since the existing lift station will be used to pump through this bypass.

b. Bypass from existing Manhole No. 402 to the north of the new pig launching structure as showing in the Contract Drawings to the new wet well (Bypass Plan Sheet 2 of 3). Expected duration of temporary pumping is 45 calendar days to allow for construction of Manhole Structure No. 4 and associated sewer pipeline construction work.

c. Bypass from Manhole No. 419 located south of the existing lift station (located in the parking lot) to the new manhole (Manhole Structure No. 2) on the 42" gravity line. Refer to Bypass Plan Sheet 3 of 3 of Contract Drawings. Expected duration of temporary pumping is five (5) months to allow time for the remaining demolition, backfill, installation, manhole structure construction, and sewer pipeline construction work after the new lift station is placed into service.

7. Temporary Bypass Pumps shall meet the following requirements:

Criteria	Value
Pump Solids Minimum Diameter	3"
Total Dry Weather Capacity (MGD)	16
Total Wet Weather Capacity (MGD)	19
Total Number of Pumps	N+1

C. Take flow measurements to confirm proposed values. Flow measurements and pumping sizing assumptions shall be included in Temporary Bypass MOPO.

D. Bypass pumping operation shall prioritize dry weather and wet weather flow pumped to Temporary and Bypass Piping:

1. Material: High density polyethylene (HDPE).
   a. Join HDPE piping by the butt-fusion method in strict accordance with the manufacturer's recommendations.
   b. Selected dimensional ratio based on hydraulic calculations, but a minimum of DR 17 shall be provided.
   c. Where indicated, the specified diameter of bypass piping shall be the minimum interior diameter of the bypass piping.
2. The layout and joints shall be capable of handling all forces exerted by bends, pressure and thrust.
3. Provide air vent for use during filling and the transfer of flow.
4. Include a tee and valve to be used for dewatering the piping upon completion of the Work.
5. Thrust block concrete: Air entrained, high early strength, 3,000 psi (min).
6. Each pump shall have a separate leg consisting of a suction isolation valve, a discharge check valve, (separate from pump), and a discharge isolation valve. The layout of which shall be capable of completely isolating the pump and check valve. All piping shall be rated for vacuum conditions.
7. Provide a check valve at the discharge location.

E. Power:

1. The pumps may be electric or diesel powered.
2. Generators shall have the same noise restrictions as the pumps.
3. All power or fuel shall be supplied by the Contractor.

F. Flow Measurement:

1. Provide flow meter to measure the total bypassed flow.

2. Record the total flow bypassed each day operating bypass pumping.

G. Controls:
   1. The Contractor shall provide all necessary instrumentation and controls to operate each pump including, but not limited to:
   2. Level controls for pump operation.
   3. High water level indicator and alarm.

H. Monitoring:
   1. Pumps and equipment shall be continuously monitored and maintained by the Contractor during periods that pumping and bypassing are required. Man all pumps continuously (24 hours per day) when in service.
   2. The Contractor shall provide alarms during bypass operations. Bypass operations need alarms to contact Contractor as the primary responder and responsible operator. Provide a remote auto-dialer capable of notifying the Contractor of pumping equipment failures.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Hydrostatic Testing Procedure of Bypass Piping:
   1. Test pressure: 100 psi.
   2. Provide a means of eliminating pipe movement during pressurization.
   3. Apply and maintain test pressure for 3 HRS to allow for initial expansion of the pipe. Reduce test pressure by 10 percent and monitor pressure for one hour. If the test pressure remains steady (within 5 percent of target value) for one hour and no leakage is indicated, then test will be deemed acceptable.
   4. Prepare hydrostatic test report and submit to Engineer in accordance with Section 01 33 00.

B. The bypass pumping and piping system shall be satisfactorily operating for a period of 24 HRS prior to commencing Work in the area requiring bypassing or performing a shut down of the lift station and/or pipeline requiring bypassing unless otherwise specified.

C. Existing Utilities:
   1. Locate existing utilities in the area selected for the bypass piping.
   2. Locate the bypass piping to minimize disturbance to existing utilities.
   3. All costs associated with relocating utilities shall be the responsibility of the Contractor.

D. Protect existing structures and equipment from damage inflicted by bypass pumping equipment. The Contractor shall be responsible for correcting any and all physical damage to the existing structures and equipment.

E. Plugging or Blocking of Flows:
   1. Incorporate both a primary and secondary plugging device upstream and downstream of the work area.
   2. Remove plugging or blocking in a manner that permits the flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

+ + END OF SECTION + +

SECTION 01 14 00

WORK RESTRICTIONS

PART 1 - GENERAL

1.1 USE OF PREMISES

A. Limit use of premises to Work in areas indicated. Do not disturb portions of site beyond areas in which Work is indicated.
   1. Limits: Confine construction operations to designated areas located within OWNER'S parcel (5102 East Ray Road, Phoenix, Arizona 85044) where the existing LS 40 is located. Confine storage of materials and support facilities to designated areas located within the project site or at CONTRACTOR's temporary construction facilities. Do not disturb areas outside of the designated limits.
   2. Driveways and Entrances: At all times, keep driveways and entrances serving premises clear and available to OWNER, OWNER'S employees, and emergency vehicles. Coordinate with the requirements of Section 01 55 00, Vehicular Access and Parking. Do not use these areas for parking or storage of materials.
      a. Schedule deliveries to minimize use of driveways and entrances.
      b. Schedule deliveries to minimize space and time requirements for on-site storage of materials and equipment.

B. Use of Existing Building: Obtain OWNER'S written permission for each use of existing building. Maintain existing building in a weather-tight condition throughout construction period. Protect building and its occupants during construction.

C. Housekeeping: Maintain all areas in a clean and orderly fashion and secured if needed to protect materials, supplies, tools, and equipment.

D. Promptly repair damage to premises caused by construction operations. Upon completion of the Work, restore premises to original condition. Any disturbance of areas outside of the designated limits shall be repaired to the original or better condition.

1.2 SUBMITTALS

A. Site Layout Plan: Site layout plan showing proposed location of any field offices, storage trailers, staging and laydown areas, temporary sanitary facilities, temporary fencing, security, fueling location(s), bottle gas storage facilities, and other areas Contractor proposes to occupy. Include site access points, employee parking areas, and any other temporary features or equipment associated with the work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 14 16

COORDINATION WITH OWNER'S OPERATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The intent of this Section is to provide CONTRACTOR a sequence to perform the Work in such a manner that continuous, uninterrupted lift station services and facilities are maintained operational throughout the construction period.

B. The sequences of Work and Schedule of Completion are specified under Section 01 11 00, Summary of Work, and Section 01 32 16.15, Construction Progress Schedule. The sequences have been assembled to maintain lift station operations during construction.

C. Except for the shutdown durations specified in this Section, CONTRACTOR'S means and methods shall be implemented such that the existing lift station or facility, shall remain in continuous satisfactory operation during the entire construction period. Work shall be so scheduled and conducted by CONTRACTOR such that it shall not impede lift station operation, compromise lift station security, create potential hazards to operating equipment and lift station personnel, or cause odor or other nuisances. In performing the Work shown and specified, plan and schedule the Work to meet both the constraints outlined in this Section and lift station operating requirements.

D. Work not specifically covered in Section 01 11 00, Summary of Work; and Section 01 32 16.15, Construction Progress Schedule or in the following paragraphs may, in general, be done at anytime during normal work hours during the Contract period, subject to the operating requirements outlined in this Section. All references to days in this Section are consecutive calendar days.

E. The option of providing additional temporary facilities that can eliminate a constraint provided it is done without additional cost to the OWNER, presents no safety hazards, and provided that all requirements of these Specifications are fulfilled.

F. CONTRACTOR is responsible for coordinating all shutdowns with the OWNER and ENGINEER. Whenever possible, combine discrete shutdown procedures identified in this Section or by CONTRACTOR into a single shutdown when the duration of the shutdowns or the Work requirements allow such combining to occur on a unit process or work area. The intent of combining procedures is to minimize the impacts upon lift station operations and processes by limiting the number of shutdowns required.

G. Do not shut-off or disconnect any operating system of the lift station, unless approved by the ENGINEER, in writing. All lift station equipment operations and shutdowns shall be executed by the OWNER, unless otherwise noted. Seal OWNER operated gates and valves to prevent unnecessary leakage. After CONTRACTOR'S Work has been completed, remove the seal to the satisfaction of

the ENGINEER.

H. This Section of the Specifications contains several references to equipment, piping, material and appurtenances to be removed or reinstalled. Refer to the Drawings, Section 02 41 00, Demolition, and other applicable Sections, for definition of the equipment, piping, material and appurtenances to be removed, turned over to the OWNER and stored on site, or to become the property of CONTRACTOR and removed from the site.

I. CONTRACTOR is responsible for supplying all temporary pipelines, valves, pumps, meters, spare parts, electrical, controls, any other appurtenances, and labor required for the installation and operation of temporary bypass lines, pumping systems, or conveyance systems required to maintain operations of the lift station during construction activities. All temporary pumps shall be provided with magnetic flowmeters capable of providing a 4 to 20 mADC output signal. Man all pumps continuously (24 hours per day) when in service. Submit to the ENGINEER, for information only, the design for all temporary lines, pumping, or conveyance systems at least 7 days prior to the commencement of the Work.

J. Unless otherwise specified, dewater process tanks and pipelines at the beginning of each shutdown. CONTRACTOR is Responsible for washing down and cleaning all tanks, basins, pipelines and other Work areas. CONTRACTOR is also for the removal of all washdown, cleaning and storm water that accumulates in the Work areas. Approximate depth of sludge, grit and other debris which can be expected to accumulate in the bottom of basins and pipelines is 18-inches. CONTRACTOR is responsible for removing this material and shall coordinate with the City prior to disposal. Removal of material shall be included as a separate item on CONTRACTOR'S Schedule of Values.

1.2 GENERAL CONSTRAINTS

A. Article 1.3, below, and Section 01 32 16.15, Construction Progress Schedule, specify the sequence and shutdown durations, where applicable, for lift station units which are to be taken out of service. The operational status of new or existing units other than the designated units shall not be interrupted by CONTRACTOR during the specified time periods. New units may only be used after the specified testing is completed and the units are accepted for use by the ENGINEER, in writing.

B. The following constraints shall be applied to all equipment and appurtenant utility systems on the lift station site.
   1. Load limits on Access Roads: Existing and new underground facilities, such as electrical duct banks, pipelines, etc., in, under and crossing lift station roads, have been designed for H-20 loading. Not exceed this weight limit and shall provide means of protecting the underground facilities.
   2. Access to Lift Station Site: An unobstructed traffic route through all lift station gates shall be maintained at all times.
   3. Safety Barriers: Place safety barriers around unsafe areas located around operational areas accessible to Lift Station Personnel.
   4. Personnel Access: Lift Station Personnel shall have access to all areas which remain in operation throughout the construction period.

5. Potable Water System: The existing potable water system shall be kept in operation at all times, unless otherwise specified in Article 1.3, below.
6. Plumbing Facilities: Sanitary facilities in the existing structures shall be operational at all times for Lift Station Operating Personnel, unless otherwise specified in Article 1.5, below. All other building plumbing systems, such as roof and floor drains, pumping, etc., shall be maintained for all structures.
7. Storm drainage: Storm drainage on the site shall be operational at all times, unless otherwise specified in Article 1.3, below.
8. Building Heating and Ventilating: In CONTRACTOR'S Work areas and areas affected by CONTRACTOR'S operations, building heating and ventilating shall be both provided and maintained in structures, including pipe galleries. The temperatures to be maintained in any area occupied by Lift Station Personnel, such as offices, lunchrooms, locker rooms, toilet rooms, facilities containing computer control equipment, etc., shall be at least 65°F and not greater than 80°F. The temperatures to be maintained in all other interior lift station areas, whether new, existing or temporary, shall be maintained at a minimum of 55°F and not greater than 90°F.
9. Power, Light and Communication Systems: Electric power, lighting service and communication systems shall be maintained in uninterrupted operation in all areas, unless otherwise specified in Article 1.3, below.
10. Sump Pumps and Sumps: All existing sumps shall be maintained in an operable condition with either existing pumps or temporary pumps provided by CONTRACTOR. Interim piping, power and controls shall be provided by CONTRACTOR, as required by the construction sequence and as directed by the ENGINEER.
11. Seal and Service Water Piping: A supply of service and seal water and the necessary connections to existing equipment shall be maintained during construction, unless otherwise specified in Article 1.3, below. Interim piping shall be provided by CONTRACTOR, as required.
12. The OWNER will assist CONTRACTOR in dewatering all lift station process Work areas. It is CONTRACTOR'S responsibility to maintain a clean and dry Work area by pumping and properly disposing of all washdown and cleaning water and stormwater that accumulates in the Work areas.
13. Draining Process Pipes and Conduits:
    a. Unless otherwise specified, the contents of pipes and conduits undergoing modifications shall be transferred to using hoses, piping, pumps, or other applicable means.
    b. If a drain is not available on the pipe to be drained, then a wet tap shall be made by CONTRACTOR using a tapping saddle and valve approved by the ENGINEER. No uncontrolled spillage of a pipe's contents shall be allowed.
    c. Any spillage shall be brought to the ENGINEER'S attention immediately in writing. Wash down any spillage to floor drains, sumps and sump pump discharge piping and then flush out the system to prevent clogging and septic odors. If spillage is not suitable for drainage system, e.g. chemical spills, etc, as determined by the ENGINEER, remove spillage by other method such as Vactor truck, as approved by the ENGINEER.
14. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated and ventilated spaces in all areas which are adjacent to his Work and which must be kept operational.

15. Dead End Valves or Pipe: Provide blind flanges on all valves or pipes which dead-end a line on a temporary or permanent basis. Blind flanges shall be braced and blocked, as required or as directed by the ENGINEER in the field.
16. Schedule all start-ups for Monday through Thursday. No start-ups will be allowed on Friday, Saturday, and Sunday.

1.3 SHUTDOWNS

A. General:
   1. A shutdown shall be defined as a portion of the normal operation of a lift station unit or conduit that has to be suspended or taken out of service in order to perform the specified Work. For each shutdown, compile an inventory of labor and materials required to perform tasks, provide an estimate of the time required (including time for the OWNER to take down and start-up the lift station unit or conduit), and a written description of steps required to complete all tasks. The inventory, the estimate, and written procedures shall be submitted to the ENGINEER for review 14 calendar days prior to the proposed start date of the shutdown. Request, in writing from the ENGINEER, approval for each shutdown a minimum of 14 calendar days prior to the proposed shutdown date. No shutdown shall be initiated until the inventory of materials and labor is verified by the ENGINEER on site at least 2 week(s) prior to the proposed start date.
   2. The Work required herein and any other Work required by the ENGINEER which may interrupt the normal lift station operations shall be accomplished at such times that will be convenient to the OWNER.
   3. Have on hand and located in close proximity to the Work area, all tools, equipment, spare parts and materials, both temporary and permanent, necessary to complete each Work category without interruption. Adequate numbers of personnel shall be scheduled for each shutdown, so that the Work shall be accomplished within the specified time frame. Prefabrication of all piping and other assemblies shall be completed, to the greatest degree possible, prior to any shutdowns. The ENGINEER shall be satisfied that CONTRACTOR has complied with these requirements, to the fullest extent possible, before shutdowns will be authorized.
   4. If CONTRACTOR'S procedures cause an unscheduled shutdown of the facilities, perform Work as necessary to immediately re-establish satisfactory operation. Notify the ENGINEER, in writing, immediately of any unscheduled shutdown. Permit OWNER'S personnel to work with CONTRACTOR'S personnel, as required, to maintain the lift station in continuous satisfactory operation. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of the facilities that result in fines levied by the U.S. Environmental Protection Agency, Arizona Department of Environmental Quality, Maricopa County Health Department Bureau of Air Pollution Control, or the Maricopa County Department of Environmental Management shall be the responsibility of CONTRACTOR if it is demonstrated that CONTRACTOR was negligent in the Work or did not exercise proper precautions in the conduct of the Work.
   5. The scheduled shutdowns during the period of CONTRACTOR'S Work will be as shown in Table 01 14 16-A. All Work requiring the lift station to be out-of-service shall be performed during the scheduled shutdowns shown. It should

be noted lift station staff shall continue to perform administrative, operation and maintenance functions during shutdowns.

6. Electrical Ductbank Installation: Shutdown and relocation of conflicting utilities alignments with electrical ductbank will only be allowed for certain types of process pipelines. Any shutdown and relocations shall follow a strict time schedule in order to minimize impact to lift station operations.

B. Shutdowns of Electrical Systems: Lock out and tag circuit breakers and switches operated by the OWNER and shall check cables and wires to be sure that they are de-energized to ground potential before Work begins. Upon completion of the Work, remove the locks and tags and notify the ENGINEER that the facilities are available for use.

1.4 OVERTIME

A. All overtime Work by CONTRACTOR necessary to conform to the requirements of this Section shall be performed by CONTRACTOR, at no additional cost to the OWNER and shall be performed in accordance with the General Conditions. CONTRACTOR shall make no claims for extra compensation as a result thereof.

1.5 MAINTENANCE OF LIFT STATION OPERATIONS SCHEDULE

A. In order to maintain a continuous lift station operation during construction, a Maintenance of Plant Operations (MOPOs) Schedule is included at the end of this Section.

B. Within each MOPO item's procedural steps, time and scheduling constraints and milestone dates may be outlined and are intended to assist CONTRACTOR in developing a sequence of Work and timing in order to maintain continuous operation of the lift station.

C. Develop a detailed description of the complete sequence of construction for all the MOPO events contained herein. The sequences shall be submitted to the ENGINEER for review and approval 14 days following the Notice to Proceed.

D. The procedures contained herein were developed based upon available information. This list does not address all required tie-ins, but only those anticipated to be of significant impact to lift station operations.

E. Is required to make all tie-ins, connections, and replacements necessary to perform the Work.

F. It is advised that Work in multiple areas of the lift station, gravity sewer and force main system shall be performed simultaneously in order to complete the entire scope of the Work within the allotted Contract time.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

1.0 LIFT STATION 40

ITEM NO./ DWG. NO.	ITEM DESCRIPTION	PROCESS UNITS OPERATING PRIOR TO SHUTDOWN	PROCESS UNITS OPERATING DURING SHUTDOWN	PROCESS UNITS OUT-OF-SERVICE DURING SHUTDOWN	IMPACT ON OTHER PROCESS UNITS	PROCEDURE	CONSTRAINTS AND REMARKS	DURATION OF SHUTDOWN
1.	Isolate Force Main #3 - Construct Pig Launching Structure #3	All	Force Main #1 and #2	Force Main #3	None	Close Valve #XXX in Valve Vault	Existing LS 40 to discharge through Force Mains #1 and #2	5 Weeks
2.	Isolate Force Main #2- Construct Pig Launching Structure #2	All	Force Main #1 and Bypass Force Main #3	Force Main #2	None	Close Valve #XXX in Valve Vault	Existing LS 40 to discharge through Force Mains #1 and #3	5 Weeks
3.	Existing Ferrous Chloride System – Temporary Electrical Change Over from LS 40 to New LS 40	All	All	Ferrous Chloride System	None	• Disconnect Electrical at LS 40 Panel XXX • Disconnect Electrical at Ferrous Chloride Panel XXX • Connect New Electrical at Ferrous Chloride System		Permanent

4	Bypass Pumping MH 402 to New Wet Well	All	All	None	None	•		7 Weeks
5	Bypass Pumping MH 419 to MH 2	All	All	None	None	•		5 Months
6	Demolish Existing LS 40	All	New Lift Station 40	Existing LS 40	None	•		Permanent

SECTION 01 14 33

WORK IN HIGHWAY RIGHTS-OF-WAY

PART 1 - GENERAL

1.1 SCOPE

A. Obtain all necessary permits, arrange all inspections required by the state and pay all charges. Conform with all applicable State Highway Department rules and regulations.

B. Work may be installed by the open cut method; however, traffic flow shall be maintained. No lanes shall be interrupted.

C. Take all means necessary to prevent accidents. Sufficient flagmen, barricades, lights, signs and all other precautions necessary shall be furnished to provide safe conditions.

D. Work shall be located as shown, and install materials, pipe, fittings, and adapters that are required to implement crossings of existing pipelines, utilities or other structures. A supply of pipe fittings, adapters and short lengths shall be on hand to expedite the crossings.

E. Pavement: When backfill is stabilized in accordance with State Highway Department requirements and these Specifications, replace the street pavement and base with pavement of similar type and equal thickness to the pavement which was removed. This pavement and base shall be constructed in complete accordance with the requirements of the State Highway Department.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 29 00

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. The items listed below, beginning with Article 1.4, refer to and are the same pay items listed in the Bid Form. They constitute all of the pay items for the completion of the Work. No direct or separate payment shall be made for providing miscellaneous temporary or accessory works, plant services, CONTRACTOR'S or ENGINEER'S field offices, layout surveys, job signs, sanitary requirements, testing, safety devices, approval and Record Drawings, water supplies, power, traffic maintenance, removal of waste, watchmen, bonds, insurance, or all other requirements of the General Conditions, Supplementary Conditions, and the Contract Requirements, unless otherwise described. Compensation for all such services, items and materials shall be included in the prices stipulated for the lump sum and unit price pay items listed herein.

B. Each lump sum and unit bid price shall be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR'S overhead and profit for each separately identified item.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

A. ENGINEER'S estimated quantities for unit price pay items, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparison of Bids. OWNER does not expressly or by implication agree that the nature of the materials encountered below the surface of the ground or the actual quantities of material encountered or required shall correspond therewith and reserves the right to increase or decrease any quantity or to eliminate any quantity as OWNER may deem necessary. Not entitled to any adjustment in a unit bid price as a result of any change in an estimated quantity and agrees to accept the aforesaid unit bid prices as complete and total compensation for any additions or deductions caused by changes or alterations in the Work directed by OWNER.

1.3 RELATED PROVISIONS

A. Payments to CONTRACTOR: Refer to General Conditions and Agreement.

B. Changes in Contract Price: Refer to General Conditions.

C. Schedule of Values: Refer to Section 01 29 73, Schedule of Values.

D. Pay Application: Refer to Section 01 33 10, Reference Forms.

1.4 GENERAL

A. **Item 1** - Mobilization:
   1. A lump sum (LS) payment for **Item 1** will be full compensation for furnishing all labor, materials, and equipment for mobilization to the project site, as specified in the bid documents, including but not limited to insurance, bonds, permits, SWPPP, temporary stormwater control measures, temporary offices as specified, temporary facilities, staging areas, equipment and labor incidental thereto. A maximum payment of 2% of total extended prices will be made for this item. This bid item shall include furnishing all labor, tools, equipment, and materials and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and specifications. Payment for this item will be amortized equally over a period of three (3) months unless otherwise approved by the ENGINEER.

B. **Item 2** – Site Work:
   A lump sum (LS) payment for **Item 2** will be full compensation for furnishing all labor, materials, and equipment for site work, including but not limited to survey, staking, clearing and grubbing, site earthwork, import materials, unclassified excavation, backfill, compaction, grading, decomposed granite, riprap, asphalt pavement, hauling and disposal, concrete pads, bollards, driveways, sidewalks, surface completions, landscaping, associated testing, protective coating systems, and cleaning as specified in the Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

C. **Item 3** – Yard Piping:
   1. A lump sum (LS) payment for **Item 3** will be full compensation for furnishing all labor, materials, and equipment for yard piping, including but not limited to staking, unclassified excavation, potholing, pipe bedding, import material, backfill, compaction, wasting material off site, surface completions, pipe, valves, fittings, components, meters, boxes, cages, racks, bibs, pipe supports, pressure testing, disinfection; connections, and other appurtenances as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

D. **Item 4** – Temporary Bypass Piping and Pumping:
   1. A lump sum (LS) payment for **Item 4** will be full compensation for furnishing all labor, materials, and equipment for temporary sewer bypass piping and pumping systems, including but not limited to temporary bypass piping and pumping as required and indicated in the Bid Documents. This bid item shall include all labor, materials, pumps, standby equipment, piping, valves, meters, access points, repair or replacement of infrastructure removed or damaged by creating access points, and monitoring required to temporarily bypass flow around the work in accordance with the specified needs of the rehabilitation method per specification 01 11 12 and replacement of piping, appurtenances, electrical items, and other work required by the contract documents. CONTRACTOR to provide the design of the bypass arrangement and describe the means and methods of accomplishing the bypass and submit to the OWNER and ENGINEER to determine conformance to project objectives.

CONTRACTOR shall submit bypass plans, designs, materials, MOPOs, startup, and testing along with any required permits, including environmental permits as required by authorities having jurisdiction, other incidental costs pertaining to and associated with the installation, operation, monitoring, and removal of temporary bypass piping and pumping as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

E. **Item 5** – Pig Launching Structures:
   1. A lump sum (LS) payment for **Item 5** will be full compensation for furnishing all labor, materials, and equipment for pig launching structures, including but not limited to excavation, backfill, materials, concrete thrust blocks, concrete collars, concrete pads, pipe supports, valves, valve boxes, equipment, components, appurtenances, startup, and testing as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

F. **Item 6** – Wet Well Excavation, Construction, and Backfill:
   1. A lump sum (LS) payment for **Item 6** will be full compensation for furnishing all labor, materials, and equipment for excavation, construction, and backfill of the wet well and concrete pads, including but not limited to excavation, excavation and shoring design installation and removal, dewatering, protection, material hauling, storing, spoil disposal offsite, all required formwork, fabrication and placement of reinforcement including but not limited to bars, ties, and supports, embedments, welded wire fabric for concrete, encasements, placing of concrete, grout, leveling, surface finishing, patching, coordination, hatches, penetrations, grating, protective coating systems, bedding, backfill, compaction, material testing, and leak testing as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

G. **Item 7** – Underground Sewer Piping and Manholes:
   1. A lump sum payment for **Item 7** will be full compensation for furnishing all labor, materials, and equipment for all underground sewer piping and manholes structures, including but not limited to, all excavation, shoring, material hauling, storage, disposal of spoils off-site, pipe materials, fittings, appurtenances, temporary plugs, all required formwork, fabrication and placement of reinforcement including but not limited to bars, ties, and supports, and welded wire fabric for concrete, encasements, grouting, coring, penetrations, leveling, manhole frames and covers, surface finishing, and protective coating systems as specified in the Bid Documents. ALL work pertaining to fine excavation, subgrade preparation, bedding, protection, backfill, and testing shall be completed by the CONTRACTOR at no additional cost. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

H. **Item 8** - Lift Station Mechanical - Pipe, Pumps, and Valves:
   1. A lump sum payment for **Item 8** will be full compensation for furnishing all labor, materials, and equipment for lift station mechanical work, including but not

limited to, all pipe, fittings, pumps, pump base elbows, pump guide rails, lifting chains, valves, gauges, actuators, brackets, combination air/vacuum valves, flow meters, pipe supports, miscellaneous concrete pads, miscellaneous metals, grouting, leveling, protective coating systems, and pressure testing as specified in the Bid Documents. ALL work pertaining to excavation, subgrade preparation, and backfill shall be completed by the CONTRACTOR at no additional cost. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

I. **Item 9** – Air Instrumentation System:
   1. A lump sum payment for **Item 9** will be full compensation for furnishing all labor, materials, and equipment for the air instrumentation system, including but not limited to, air compressors, tanks, piping, valves, gauges, appurtenances, shade canopy structures, concrete pads, protective coating systems, testing, and startup as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

J. **Item 10** – Forcemains:
   1. A lump sum payment for **Item 10** will be full compensation for furnishing all labor, materials, and equipment for the sewer forcemains, including but not limited to, pipe materials, fittings, appurtenances, excavation, bedding, backfill, compaction, bypassing, and testing as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

K. **Item 11** – Electrical Building:
   1. A lump sum payment for **Item 11** will be full compensation for furnishing all labor, materials, and equipment for the electrical building, including but not limited to, concrete footings and foundations, concrete pads, housekeeping pads, concrete stoops, CMU building walls, insulation, and finishes; ceiling materials; roofing system; access ladder, metal screen walls, miscellaneous metals; doors and hardware; windows; frames, down spouts, drains splash blocks; trench drains; HVAC systems and ductwork including startup, testing and balancing; all plumbing and fixtures, pipe, valves and fittings, protective coating systems and finishes, fire extinguishers, signage, and building inspections as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

L. **Item 12** – Biofilter Odor Control Facilities:
   A lump sum payment for **Item 12** will be full compensation for furnishing all labor, materials, and equipment for the Biofilter Odor Control facilities, including but not limited to, all labor, materials, equipment, and incidentals needed to install the biofilter odor control facilities as required by the Bid Documents. CONTRACTOR shall ensure installation and operation of the following, biofilter control facilities, media, blower, utilities relocation, duct work, concrete pads, housekeeping pads, and other accessories as shown on the drawings, CONTRACTOR shall provide all excavation, subgrade preparation, and backfill as required by the drawings and specifications. CONTRACTOR shall provide O&Ms, performance testing, any required permits as required by authorities

having jurisdiction, and any other costs pertaining to and associated with the installation of new biofilter odor control facilities. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

M. **Item 13** – Ferrous Chloride Storage and Pumping Facilities:
   1. A lump sum payment for **Item 13** will be full compensation for furnishing all labor, materials, and equipment for installation of the force main odor control facilities. Provide all labor, materials, equipment, and incidentals needed to install the ferrous chloride storage and pumping facilities as required by the Bid Documents. CONTRACTOR shall ensure installation and operation of the following, ferrous chloride storage and pumping facilities, including but not limited to all piping, fittings, valves, showers, eyewash stations, drains, grating, concrete pads, footings, sidewalks, stairs, tanks, accessories, signage, protective coating systems and finishes as shown on the drawings. CONTRACTOR shall provide all excavation, subgrade preparation, and backfill as required by the drawings and specifications. CONTRACTOR shall provide all materials, labor, and equipment to maintain temporary operation of existing Ferrous Chloride Storage and Pumping facilities for operation of new pump station until the new ferrous chloride system is complete. CONTRACTOR shall provide O&Ms, all testing, any required permits as required by authorities having jurisdiction, any other incidental costs pertaining to and associated with the installation of new force main odor control facilities. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

N. **Item 14** – CMU Site Walls and Gates:
   1. A lump sum payment for **Item 14** will be full compensation for furnishing all labor, materials, and equipment for the CMU site walls, vehicular gates, and man-gates, including but not limited to, concrete footings and foundations, concrete pads, CMU walls, reinforcement, man-gates, rolling gates, gate operator systems, ultra-barrier, protective coating systems and finishes, signage, and temporary fencing and gates as required to maintain existing site security as specified in Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

O. **Item 15** - Demolition of Existing Lift Station Site and Facilities:
   1. A lump sum payment for **Item 15** will be full compensation to provide all labor, equipment, cleaning, rinsing, disposal, and any other incidentals required for the demolition of the existing lift station, existing electrical facilities, lift station piping, sewer piping, water piping, electrical wiring, conduit, duct banks, concrete, asphalt, CMU walls, gates, ferrous chloride facility including residual ferrous chloride, and other site features as shown on the drawings. Demolition and removals shall conform to the requirements of drawings and specifications. CONTRACTOR shall obtain any required permits for disposal or transport of materials. All materials and equipment removed from the site, shall become the property of CONTRACTOR, except for those which OWNER has identified and marked for their use per drawings or identified by the OWNER at the preconstruction meeting. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

P. **Item 16** - Electrical, Instrumentation, and Controls:
   1. A lump sum payment for **Item 16** will be full compensation for furnishing all labor, materials, and equipment for all electrical, instrumentation, and control, including but not limited to, wiring, conduit, pull boxes, handholes, manholes, grounding systems, colored concrete duct banks with warning tape, transformers, standby generator provided with full tank of fuel, automatic transfer switch, variable frequency drives, control panels, switchgear, service entrance sections, arc flash study, labels, lighting, switches, heaters, thermostats, instruments, sensors, site lighting, site security, programming, O&Ms, spare parts, electrical green tag inspections, and testing as specified in the Bid Documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

Q. **Item 17** – Startup and Testing:
   1. A lump sum payment for **Item 17** will be full compensation for furnishing all labor, materials, and equipment for startup, checkout, testing, training, and commissioning support. This bid item shall include furnishing all labor, tools, equipment, and materials to perform startup and testing along with all required O&Ms, spare parts, permits, including environmental permits as required by authorities having jurisdiction, other overhead and incidental costs pertaining and associated with the testing and adjustment on equipment, manholes, drain lines, sewer pipes, pumps, motors, biofilter, electrical, generator, and instrumentation, all as needed to meet the requirement defined in the Contract Drawings and specifications. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

R. **Item 18** – Demobilization:
   1. A lump sum payment for **Item 18** will be full compensation for furnishing all labor, materials, and equipment for demobilization from the completed project site. A minimum of amount of 1% of total extended prices will be made for this item. Payment for this item will be contingent upon completion of final punch list items, final record drawings, final O&Ms, restoration of disturbed areas associated with the work, final cleaning, closeout documents, and warranty documents. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER.

S. **Item 19** – Owner's Allowance - SRP Utility Coordination and Installation Work:
   1. **Item 19** will be an allowance used at the discretion of the Owner for any SRP utility coordination and installation work that may be required associated with providing utility power for the project.

T. **Item 20** – Owner's Allowance:
   1. **Item 20** will be an allowance used at the discretion of the Owner for any unforeseen or additional items requested and authorized in writing by the Owner.

PART 1 - PRODUCTS (NOT USED)

PART 2 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Preliminary Schedule of Values is an itemized list that establishes the value or cost of each major part of the Work and the division of Work between CONTRACTOR and subcontractors.

B. The Preliminary Schedule of Values shall include all items of Work in the Contract Documents.

C. The Schedule of Values is a detailed itemized list that establishes the value or cost of each detailed part of the Work. It and the Progress Schedule updates specified in Section 01 32 16.15, Construction Progress Schedule, shall be used as the basis for preparing progress payments. Quantities and unit prices shall be included in the schedule of values. Lump Sum amounts may be included in the schedule of values when approved by or required by the ENGINEER.

D. The Schedule of Values shall include all Work for all Maintenance of Plant Operations (MOPO) Work as specified in Section 01 14 16, Coordination with OWNER'S Operations.

1.2 PREPARATION

A. The Preliminary Schedule of Values:
   1. Preliminary Schedule of Values shall show an itemized list of Work for each major work area included in the Work for each payment item included in the Contract.
   2. Preliminary Schedule of Values shall show the division of Work between CONTRACTOR and subcontractors by two methods, one for each Section of the Specifications and also one for each structure.
   3. Preliminary Schedule of Values shall show breakdown of labor, materials equipment and other costs used in preparation of the Bid for CONTRACTOR and subcontractors.
   4. Costs shall be in sufficient detail to indicate separate amounts for each Section of the Specifications and for each structure.
   5. May include an item for bond, insurance, and temporary facilities.
   6. Preliminary Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.
   7. Use Table of Contents of the Specifications as basis for Preliminary Schedule of Values format and identify each item with number and title in the Table of Contents. Also, use each structure as basis for Schedule of Value format. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
   8. When requested by ENGINEER, support values with data that will substantiate their correctness.

9. The sum of the individual values shown on the Preliminary Schedule of Values shall equal the total Contract Price.
10. Each item shall include a directly proportional amount of CONTRACTOR'S overhead and profit.

B. The Schedule of Values:
1. Schedule of Values shall show breakdown of quantities, labor, materials, equipment, and other costs used in preparation of the Bid for each item in the Schedule of Values.
2. Schedule of Values shall show all Work under the index areas listed in Paragraph 1.1.D., above.
3. Costs shall be prepared by two methods, one for each Section of the Specifications and one for each structure. They shall be in sufficient detail to indicate separate amounts for each Section of the Specifications and subsections therein and also separate amounts for each structure. Amounts shall be included for each type of Work specified, in a manner approved by the ENGINEER.
4. Include separate pay items for Mobilization and Demobilization, as specified in the Contract Documents.
5. Fifteen percent of the total cost of each major equipment item is allotted to the cost of Shop Drawing preparation, Operation and Maintenance Manuals, Testing and Training. Approval of the equipment submittal is required prior to payment for Shop Drawings. For major equipment, an executed purchase order may be requested by the ENGINEER for verification prior to approval of payment for Shop Drawings. This amount will be released upon approval, by the ENGINEER, three percent is apportioned to Testing and four percent each to the remaining items.
6. Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.
7. Use Table of Contents of the Specifications and the form included with Section 01 33 00, Submittal Procedures, as basis for Schedule of Values format and identify each item with number and title in the Table of Contents. Also, use each structure as basis for schedule format. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
8. When requested by ENGINEER, support values with data that will substantiate their correctness.
9. The sum of the individual values shown on the Schedule of Values shall equal the total Contract Price.
10. Each item shall include a directly proportional amount of CONTRACTOR'S overhead and profit.
11. Schedule of Values shall show the purchase and delivery costs for materials and equipment that CONTRACTOR anticipates he shall request payment for prior to their installation.
12. Include a separate pay item for Maintenance of Plant Operations (MOPO) Work for each major Work area.
13. Include a separate pay item for: Construction Photographs; Temporary Facilities; Temporary Controls; Progress Schedule; General Conditions; and Field Engineering.
14. Include a separate pay item for all Allowances.
15. The Schedule of Values shall be prepared to a level of detail equal to or greater than required by the Supplementary Conditions.

16. ENGINEER may furnish template that shall be used for Schedule of Values and Pay Application Breakdown.

1.3 ENGINEER'S estimated quantities for unit price pay items, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparison of Bids. OWNER does not expressly or by implication agree that the nature of the materials encountered below the surface of the ground or the actual quantities of material encountered or required shall correspond therewith and reserves the right to increase or decrease any quantity or to eliminate any quantity as OWNER may deem necessary. CONTRACTOR is not entitled to any adjustment in a unit bid price as a result of any change in an estimated quantity and agrees to accept the aforesaid unit bid prices as complete and total compensation for any additions or deductions caused by changes or alterations in the Work directed by OWNER.

1.4 SUBMITTALS

A. Submit the Preliminary Schedule of Values to ENGINEER for review within 7 days after the Notice to Proceed.

B. Submit the Schedule of Values to ENGINEER for review within 30 days after the Notice to Proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 01 31 13

PROJECT COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. As more fully set forth in of the General Conditions, sole responsibility for coordination of all of the Work, belongs to CONTRACTOR. Supervise, direct and cooperate fully with all subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the Work within the Contract Time.

B. As more fully set forth in of the General Conditions, Cooperate with and coordinate the Work with the work of any other contractor, including the following, utility service companies or OWNER'S employees performing work at the site:
   1. Salt River Project (SRP).
   2. Southwest Gas, as required.
   3. COX Communications, as required.
   4. CenturyLink Communications, as required.

C. CONSTRACTOR shall not be responsible for damage done by contractors not under CONTRACTOR'S jurisdiction and will not be liable for any such loss or damage, unless it is through the negligence of CONTRACTOR.

D. Coordinate the Work with the work of others to assure compliance with schedules.

E. Attend and participate in all project coordination or progress meetings and report on the progress of all Work and compliance with schedules.

F. Maintain sufficient competent personnel, drafting and CADD equipment and supplies at the site for the purpose of preparing layout, coordination and Record Drawings. These drawings shall supplement the Contract Documents, and the working and Shop Drawings as necessary to correlate the Work of various trades. Where such drawings are to be prepared by the mechanical, electrical, plumbing, or heating and ventilating subcontractors, ensure that each subcontractor maintains the required personnel and facilities at the site.

G. It is the duty of the CONTRACTOR to determine that all necessary permits have been obtained. The CONTRACTOR, at his own expense, shall obtain, maintain and close all the required permits which have not been furnished.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 31 19.13

PRE-CONSTRUCTION MEETINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Date, Time and Location: Conference will be held after notice of award of the Contract. ENGINEER will fix the date, time and location of the meeting, within thirty (30) days of notice of award.

B. ENGINEER shall prepare agenda, preside at meeting, and prepare and distribute a transcript of proceedings to all parties.

C. CONTRACTOR shall provide data required, contribute appropriate items for discussion, and be prepared to discuss all items on agenda.

D. Unless previously submitted to ENGINEER, bring to the conference a preliminary schedule of each of the following:
   1. Progress Schedule.
   2. Shop Drawing and Sample submittals.
   3. Schedule of Values.

1.2 REQUIRED ATTENDANCE

A. Conference shall be attended by CONTRACTOR’S Project Manager, its superintendent and its major subcontractors and major equipment suppliers as CONTRACTOR deems appropriate.

B. OWNER'S representative.

C. ENGINEER.

D. Representatives of governmental agencies having any degree of control or responsibility, if available.

E. Utility company representatives.

1.3 PURPOSE

A. The purpose of the Pre-construction conference is to designate responsible personnel and establish working relationships. Matters requiring coordination will be discussed and procedures for handling such matters will be established. A complete agenda will be furnished to CONTRACTOR prior to the Pre-construction conference date. However, CONTRACTOR shall be prepared to discuss all of the following; but the meeting will not necessarily be limited to the following:

1. Designation of responsible personnel.
2. Subcontractors.
3. Coordination with other contractors and projects.
4. Progress schedule.
5. Processing of Shop Drawing Submittals.
6. Schedule of Shop Drawing submittals.
7. Processing of Field Orders, Requests for Information and Clarification and Change Orders.
8. Requirements for copies of Contract Documents.
9. Insurance in force.
10. Schedule of values.
11. Processing and Schedule of Payments.
12. Use of premises.
13. CONTRACTOR responsibility for safety and first aid procedures.
14. Site Security.
15. Housekeeping.
16. Field Offices.
17. Maintaining Record Drawings.
18. Letter of Notice to Proceed.
19. Permits.
20. Emergency Telephone Numbers.
21. Operation and Maintenance Manuals.
22. Temporary Utilities.
23. I&C Inspection & Testing Services Coordination
24. Electrical Arc Flash Coordination
25. Any other project related items.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 31 19.23

PROGRESS MEETINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Date and Time:
   1. Regular Meetings: Bi-weekly on a day and time agreeable to OWNER, ENGINEER and CONTRACTOR.
   2. Other Meetings: As needed and/or required in other specific specification sections.

B. Place: CONTRACTOR'S field office at Project site, or other mutually agreed upon location.

C. The ENGINEER shall conduct weekly progress meetings, record and distribute minutes of the meeting to all attendees and others as requested. At a minimum, the agenda will include: Requests for Information (RFI) and submittal status, past week's progress and a 3-week look-ahead schedule to include upcoming inspections, current issues, long lead items, critical issues and the next scheduled meeting date.

D. Provide data required and be prepared to discuss all items on agenda.

1.2 MINIMUM ATTENDANCE

A. CONTRACTOR:
   1. When needed for the discussion of a particular agenda item, require representatives of subcontractors or suppliers to attend a meeting.

B. ENGINEER.

C. OWNER'S representative, if required.

D. Others, as appropriate.

E. Representatives present for each party shall be authorized to act on their behalf.

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Transcript of previous meeting.
   2. Progress since last meeting.
      a. CONTRACTOR'S 3-week schedule. Schedule shall show intended work 3 weeks ahead as well as completed work since the last progress meeting.

   3. Completion status.

4. Planned progress for next period including a 3-week look-ahead schedule to include upcoming inspections.
5. Document and track to correction and closure any problems, conflicts, issues, and observations that are voiced by anyone of the project team.
6. Status of Shop Drawings, submittals, long lead items, RFI and RFAs.
7. Change Orders.
8. Pay Requests.
9. Quality Standards and Control.
10. Schedules, updated Project Schedules, including off-site fabrication and delivery schedules; corrective measures, if required.
11. Coordination between parties.
12. Permits.
13. Safety concerns.
14. Construction Photographs.
15. Record Drawings.
16. Warranty Requests.
17. Punch List Status.
18. Other business.
19. Next meeting date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 32 16.15

CONSTRUCTION PROGRESS SCHEDULE (CPM)

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes the Progress Schedule requirements to ensure that interim milestone dates will be met and completion of the Work will be accomplished within the time established. ENGINEER'S opinions concerning the various scheduling documents and reports are not controlling CONTRACTOR'S independent judgement concerning means, methods, and sequences of construction CONTRACTOR employs. Sole responsibility for meeting the Contract time(s) given in these Contract Documents, belongs to CONTRACTOR.

B. No later than 14 calendar days after the Notice to Proceed, submit a Preliminary Progress Schedule. The Preliminary Progress Schedule shall be referenced to time. The balance of Work leading to Substantial Completion of the Project shall be included, in a summary format.

C. No later than 14 calendar days after the Notice to Proceed, submit to the ENGINEER a 90-day Bar Chart Schedule prepared in accordance with Article 1.1 through 1.6, herein. The 90-day Bar Chart Schedule shall detail the first 90 calendar days of the Project.

D. No later than 14 calendar days after the Notice to Proceed, submit to the ENGINEER a full Progress Schedule prepared in accordance with Articles 1.1 through 1.7, herein. Upon review and acceptance, the CONTRACTOR'S submitted full progress schedule, described in this paragraph, will be deemed to be the "Baseline Schedule". (The use of the term "Baseline Schedule" refers to the early dates; the late dates are for the purpose of calculating float, and do not represent the schedule). This Baseline Schedule shall be used by the CONTRACTOR for planning, scheduling and executing the Work and for monitoring and reporting progress to the ENGINEER. No changes to the Baseline Schedule may be made by the CONTRACTOR without the approval of the ENGINEER. The Baseline Schedule shall be appended with "-00" indicating this is the initial and approved Baseline Schedule.

E. To ensure completion of the Work within the contract times established, all of CONTRACTOR'S activities shall be scheduled and monitored by use of a Critical Path Method (CPM) Progress Schedule. Provide a CPM Schedule for Work done under this Contract, in accordance with this Section, and the sequence and progress of Work requirements included under Section 01 11 00, Summary of Work, and Section 01 14 16, Coordination with OWNER'S Operations, the Supplementary Conditions and the Construction Sequence Diagram.

F. The Progress Schedule shall be prepared by CONTRACTOR using the Critical Path

Method (CPM) utilizing the latest version of Primavera Project Planner software with Primavision (Primavera Project Planner and Primavision are U.S. registered trademarks of Primavera Systems, Inc., Bala Cynwyd, PA), or approved equal as determined by the OWNER and ENGINEER, conforming to the requirements hereinafter described.

1.2 SCHEDULING CONSULTANT

A. Engage, at CONTRACTOR'S expense, a Scheduling Consultant or a qualified CONTRACTOR'S employee who has experience and is skilled in the time and cost application of CPM network techniques using Primavera on similarly sized and scoped construction projects to assist in the preparation of the Project Schedule. Prior to engaging a Scheduling Consultant or a qualified CONTRACTOR'S employee, Submit to the ENGINEER:
   1. The name and address of the proposed Scheduling Consultant or qualified CONTRACTOR'S employee and the names of those persons who would be dedicated to this Project.
   2. Sufficient information to show that the proposed Scheduling Consultant or qualified CONTRACTOR'S employee and the persons dedicated to this Project, have the qualifications to meet the Progress Schedule requirements.

B. The ENGINEER shall have the right to approve or disapprove the proposed Scheduling Consultant or qualified CONTRACTOR'S employee and will notify CONTRACTOR of his decision within 14 calendar days from receipt of information. In case of rejection, CONTRACTOR shall submit qualifications of another consultant within 14 calendar days for renewed considerations. Such approval or disapproval does not release CONTRACTOR from his obligations under this Contract.

1.3 LOGIC DIAGRAM

A. CONTRACTOR'S Scheduling Consultant or qualified CONTRACTOR'S employee shall prepare and submit a complete reproducible set of pure logic diagrams as generated by Primavera on 11-inch by 17-inch drawings. The logic diagrams shall be grouped by Area and show the order and interdependence of activities and the sequence and quantities in which the Work is to be accomplished. Interrelationships to or from activities outside the area shown will be depicted by an activity symbol with activity number and description shown from the Primavera program. The basic concept of Precedence Diagramming Method (PDM) network scheduling shall be followed to show how the start of a given activity is dependent on the completion of preceding activities and how its completion may affect the start of following activities. The level of schedule detail shall define the day-to-day activities of the construction Work. No construction activity duration shall be longer than Ten (10) working days without prior approval.

B. The critical path shall be distinguished from other paths on the network. The logic diagrams shall be banded by major work systems, including one system for procurement and by specific area within each system. Logic diagrams shall include the following:
   1. Activity number.

2. Activity description.
3. Activity duration (work days).
4. Critical path denoted.
5. Slack or float of each activity.
6. Responsibility code (e.g., CONTRACTOR, subcontractors, trades, operations, suppliers, ENGINEER, or other party responsible for accomplishment of an activity).

C. In addition to construction activities, network activities shall include the submittal and approval of samples of materials, shop and working drawings, and fabrication of special materials. It shall include all documents and proofs of compliance required by the Contract Documents for Final Inspection and Acceptance of the Work.

D. The Schedule Document shall include a System and Acceptance schedule within the project CPM schedule. This schedule will identify all equipment and systems that require testing, training and acceptance by the City of Phoenix. The durations and sequences of the systems testing and acceptance must be as specified in the various sections of the contract specification. Each system will contain, but will not be limited to, all of the following activities and constraints:
1. Interface between the construction activities and their respective system.
2. CONTRACTOR'S pre-testing work.
3. Submittal and Approval of the CONTRACTOR'S Pre-testing Data and checklist, as appropriate.
4. Sufficient notification time to the City of Phoenix prior to system testing.
5. Submittal and Approval of the Preliminary and Final As-Built Drawings.
6. Submittal and Approval of the Preliminary and Final O&M Manuals.
7. Submittal and Approval of Testing Procedures.
8. All other systems that are required to be tested and accepted prior to the specific system being tested.
9. System Testing by the City of Phoenix.
10. Other outside agencies, utilities, etc., that are required to test, witness and accept the system.
11. Submittal and Approval of the Training Syllabus, Training Manual, and Training Video.
12. Performance of Training.

E. All activities of the ENGINEER/OWNER that affect progress and special dates required by the Contract shall be shown.

F. Schedule calculations must retain the logic between predecessors and successors ("retained logic" mode) even when the successor activity(s) starts and the predecessor activity(s) has not finished (out-of-sequence progress). Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") are not be allowed.

G. Schedule activities on a Calendar to which the activity logically belongs. Develop calendars to accommodate any contract defined work period such as a 7-day calendar for City/Owner activities, concrete cure times, etc. Develop the default

Calendar to match the physical work plan with non-work periods identified including weekends and holidays. Develop Seasonal Calendar(s) and assign to seasonally affected activities as applicable.

1.4 MATHEMATICAL TABULATIONS

A. The mathematical tabulation of the network diagram shall include tabulation of each activity shown on the detailed network diagram.

B. The information listed below shall be furnished as a minimum for each activity. All submittal and updates shall consist of the reports described below and electronic copy of Primavera schedule files. The minimum required information includes:
   1. Activity number.
   2. Activity description.
   3. Activity duration (work days).
   4. Earliest start date (calendar date).
   5. Earliest finish date (calendar date).
   6. Latest start date (calendar date).
   7. Latest finish date (calendar date).
   8. Slack or float of each activity.
   9. Quantities involved for each construction activity with manhour requirements and dollar values.
   10. Critical path activities denoted.
   11. Work days calendar which extends for not less than the length of the contract, plus six months.

C. The mathematical tabulation shall be in the form of computer-generated reports. The reports shall be bound in booklet form, indexed, and separated by tabbed dividers. Computer-generated reports, of the following sorts, provided by CONTRACTOR:
   1. Milestone Report.
   2. Critical Path Activities Report by Early Start.
   3. Area Schedule Report for each System by Area/Early Start/Total Float.
   4. Responsibility Schedule Report for each System by Responsibility/Early Start/Total Float.
   5. 60-Day Look-Ahead Report by Area for Each System, then by activity number (with update line).

1.5 NARRATIVE REPORT

A. Prepare, and include with his original Progress Schedule submission, a narrative report describing the contract requirements and objectives and CONTRACTOR'S plan and schedule for achieving those requirements and objectives. The narrative shall describe the methods of operation, the resources to be employed, time frames for the construction of each of the major systems on the project, and time frames for accomplishment of the specified milestones and project completion.

B. It shall also include, but not be limited to:
   1. A justification and identification of activities that were worked out of sequence.

2. A description of problem areas.
3. Current and/or anticipated delaying factors and their potential impact.
4. An explanation of corrective action (recovery plan) either taken or proposed for all critical areas.
5. A listing of al intermediate contractual milestones with their respective float and schedule analysis.
6. Define activities that were not started or completed as scheduled and provide explanation.
7. Identify outstanding “Requests for Information (RFI’s)” and discuss their schedule impact.
8. To demonstrate the schedule development and updates have been coordinated, reviewed, and approved by the applicable Project Management Personnel, Project Supervisory Personnel, and Major Subcontractors, the narrative reports shall be signed by the Project Manager, Project Superintendent, and Major Subcontractors acknowledging their review and acceptance of the proposed baseline schedule and progress updates prior to submitting to ENGINEER for review. Major Subcontractors, for the purpose of this section, are defined as Subcontractors performing more than 10% of the contract value work.

1.6 PROGRESS SCHEDULE SUBMITTAL

A. No later than 14 calendar days after the Notice to Proceed, submit to the ENGINEER a 90-day Bar Chart Schedule. During this period CONTRACTOR and the Scheduling Consultant shall meet with the ENGINEER and the OWNER for a minimum of a 1-day workshop session to review technical requirements and schedule development methods and procedures. The ENGINEER may provide preferential layout formats for the schedules. The 90-day Bar Chart Schedule will be reviewed by the ENGINEER within 14 calendar days of receipt or request for adjustment. A meeting, or meetings, may be required with CONTRACTOR’S Scheduling Consultant during this period in order to expedite acceptance or adjustment. Any adjustments required after this period shall be made and resubmitted by CONTRACTOR within 14 calendar days.

B. No later than 14 calendar days after the Notice to Proceed, 14 calendar days after the complete Progress Schedule has been accepted by the ENGINEER, CONTRACTOR submit to the ENGINEER a full Progress Schedule prepared in accordance with Articles 1.1 through 1.5, above. During this period the ENGINEER, CONTRACTOR and CONTRACTOR’S Scheduling Consultant shall meet biweekly to review the progress of the development of the full Progress Schedule. Lack of progress in the development of the Progress Schedule shall be cause for suspension of any Progress Payment. The complete Progress Schedule will be reviewed by the ENGINEER within 14 calendar days of receipt or request for adjustment. A meeting, or meetings, may be required with CONTRACTOR’S Scheduling Consultant during this period in order to expedite acceptance or adjustment. Any adjustments required after this period shall be made and resubmitted by CONTRACTOR within 7 calendar days.

C. If, in the preparation of the Progress Schedule, CONTRACTOR reflects a completion date or milestone date different than that specified in the Contract, this in no way voids the dates set therein. The dates as specified in the Contract govern. Where the Progress Schedule reflects a completion date or milestone date earlier than specified, the ENGINEER may accept such schedule with CONTRACTOR specifically understanding that no claim for additional Contract Time or compensation shall be brought against the OWNER as the result of failure to complete the Work by the earlier date shown on the Progress Schedule.

1.7 FAILURE TO SUBMIT

A. CONTRACTOR's failure to submit the Progress Schedule in the form indicated within the required time frames shall be cause for suspension of any Progress Payment.

1.8 UPDATING THE PROGRESS SCHEDULE

A. Updates:
   1. Monthly updates to the mathematical tabulation are the CONTRACTOR'S responsibility. The updated mathematical tabulation shall include the following data for each activity:
      a. Actual start date (for started activities).
      b. Actual finish date (for completed activities).
      c. Percent complete.
      d. Current projected early/late start/finish dates (for activities not started).
      e. Current early/late finish dates (for uncompleted activities).
      f. Current Total float.
      g. Critical path activities noted.
   2. Activities shall be updated by physical percent complete, not percent complete by calculation.
   3. Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying, or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited. Indicate assumptions made and the basis for any logic, constraint, duration, and calendar changes used in the creation of the recovery plan. Any additional resources, manpower, or daily and weekly work hour changes proposed in the recovery plan must be evident at the work site and documented in the Narrative Report.
   4. If, in the preparation of the Progress Schedule, CONTRACTOR reflects a completion date or milestone date different than that specified in the Contract, this in no way voids the dates set therein. The dates as specified in the Contract govern. Where the Progress Schedule reflects a completion date or milestone date earlier than specified, the ENGINEER may accept such schedule with CONTRACTOR specifically understanding that no claim for additional Contract Time or compensation shall be brought against the OWNER as the result of failure to complete the Work by the earlier date shown on the Progress Schedule.
   5. CONTRACTOR'S Schedule Update shall include a narrative report which shall include a description of the current progress/status of each area of the project,

a description of the progress for the period, a description of the critical path, a discussion of current or potential delays, Change Orders (pending or approved), or other problems. The narrative report shall include the review and acceptance statements with signatures of those listed in 1.5 B. 8.

6. Provide the ENGINEER with an electronic copy in pdf format and the electronic copy of Primavera schedule files. Network diagrams shall be submitted with the tabulation if there are any proposed revisions to network logic, interim milestones, contract completion, or as directed by the ENGINEER. The updated tabulations shall reflect the current status of activities, as outlined on the baseline network diagram. The updated tabulation reports shall reflect all changes in dates, remaining durations, and float time. If any delays have occurred, these shall be noted for time consideration. The Schedule Updates shall be appended with sequential numbering starting at "-01."

B. Monthly Schedule Meeting:
   1. Recording the start and completion dates of each scheduled work activity with the remaining duration for activities started but not completed, including procurement activities is the CONTRACTOR'S responsibility. On one day each month, at least one week prior to the monthly progress meeting, CONTRACTOR and the Scheduling Consultant shall meet with the ENGINEER to tour the site and review and updated information gathered by CONTRACTOR during the month. After acceptance of CONTRACTOR'S updated data, CONTRACTOR'S Scheduling Consultant shall use this information to update the mathematical tabulations and to generate a Monthly Schedule Update.

C. Network Revisions:
   1. Conditions may develop that require revisions to logic or durations of the original network. If during the progress of the Work events develop that necessitate changes in the original Progress Schedule, propose such changes so as to depict the current mode of operation and provide the ENGINEER with a revised network diagram. Any revision to the original logic or original durations must be accepted by the ENGINEER, in writing. After acceptance, logic/duration revisions will be incorporated into the Progress Schedule and will be addressed in the monthly narrative report by means of both a description of the revisions and a listing of those network elements affected by such change. All changes resulting from Change Order(s), additions or deletions, will be fully incorporated into the Progress Schedule on the first update after the Change Order approval, including all adjustments to the man-hours.
   2. Revisions and additions to the accepted network diagrams and mathematical tabulations shall be submitted in formats specified by the ENGINEER.
   3. The list of revisions and additions will include the following, when applicable:
      a. Addition and deletion of activities.
      b. Addition and deletion of relationships.
      c. Changes to activity descriptions and durations.
      d. Changes to relationship types and lag codes.
      e. Changes to contract milestone dates and approved constraint dates.
      f. Changes to dollar values resulting from approved Change Orders.
      g. All other revisions to the network logic.

4. Any revisions shall be reviewed and accepted by those listed in 1.5 B. 8.

1.9 TIME IMPACT ANALYSIS FOR CHANGE ORDERS, DELAYS, AND TIME EXTENSIONS

A. Change Orders, Delays, and Time Extensions:
   1. When a Change Order(s) is (are) proposed by the ENGINEER or CONTRACTOR, or delays are experienced, submit a Time Impact Analysis (TIA) illustrating the influence of each Change Order or delay on any specified intermediate milestone date(s) or contract completion date. Each TIA shall include a sketch (fragnet) demonstrating how CONTRACTOR proposes to incorporate the change(s) or delay(s) into the current Progress Schedule. The fragnet will include all logic changes and additions required as a result of said Change Order(s) or delay(s).
   2. This fragnet will show all CPM Logic revisions for the Work in question and its relationship to other activities in the network plan. Additionally, the analysis shall demonstrate the time impact, based on the date the change was given to CONTRACTOR, the status of construction at that point in time, and the activity duration of all affected activities. The activity duration used in this analysis shall be those included in the latest update of the Progress Schedule, closest to the time of delay as adjusted by mutual agreement in writing.

B. Submission:
   1. Each Time Impact Analysis shall be submitted within 7 calendar days after a delay occurs or a notice of change or Change Order is given to CONTRACTOR. In cases where CONTRACTOR does not submit a Time Impact Analysis for a specific change or delay within the specified period of time, it shall be mutually agreed that no time extension is required. TIA schedules and files shall be appended with “TIA-xx” indicating the sequential number of submitted TIAs.

C. Evaluation:
   1. Final evaluation of each Time Impact Analysis by the ENGINEER shall be made within 7 calendar days after receipt, unless subsequent meetings and negotiations are necessary. Adjustments in the Contract time for performance shall be made only by written Change Order. Upon acceptance by the ENGINEER, fragnets illustrating the influence of changes and delays shall be incorporated into the current schedule by CONTRACTOR during the first update after agreement is reached.
   2. The time difference between the Early Finish date and the Late Finish date is defined as “float.” The “float” belongs to the Project and may be used by CONTRACTOR or the OWNER to benefit the Project. Changes or delays that influence activities in the network with “float” and do not extend the Critical Path (the sequence of activities with zero days float) shall not be justification for an extension of Contract time for performance.

1.10 RECOVERY SCHEDULE

A. In the event that the Progress Schedule update mathematical analysis indicates that

the Project, or progress towards any interim milestone requirement, falls 20 or more work days behind schedule and there is no excusable delay or change to support a time extension, prepare and submit a Recovery Schedule for acceptance by the ENGINEER. Also, revise logic or durations to cause the mathematical analysis to show the Project on schedule. The Recovery Schedule shall be submitted five (5) calendar days after the Progress Schedule Update is submitted.

B. Provide additional manpower, equipment, or materials or work additional shifts, or expedite procurement to complete activities within the accepted intermediate or Contract completion dates, at no additional cost the OWNER. Upon acceptance of the Recovery Schedule by the ENGINEER, incorporate the Recovery Schedule into the current Progress Schedule.

C. Lack of Action:
   1. CONTRACTOR'S refusal, failure, or neglect to take appropriate recovery action or to submit a written recovery statement shall constitute reasonable evidence that CONTRACTOR is not prosecuting the Work, or separable part, with the diligence that will ensure its completion within the applicable Contract time. Such lack of action shall constitute sufficient basis for the ENGINEER to recommend the withholding of some or all of any payment due, or shall be considered grounds for termination by the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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+ + END OF SECTION + +

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Retain a professional photographer or an acceptable person, as determined by the ENGINEER, to perform the services specified below.

B. Obtain ENGINEER'S approval of the photographer selected prior to taking first photographs. Submit qualifications and experience record of photographer to ENGINEER.

1.2 PHOTOGRAPHS

A. The CONTRACTOR shall be responsible to take regular photographs or coordinate with the ENGINEER to provide a record of progress on a regular basis and at monthly milestones. Photos shall have date and time.

B. Take a minimum of ten (10) color digital photographs weekly of the completed or substantially completed Work at Project Completion. These photographs shall be submitted with the Final Application for Payment. These photographs are not part of the photographs required under Paragraph 1.2.A., above.

C. The CONTRACTOR shall take color digital photographs daily of all underground work in progress; work being done that will be exposed above ground shall be photographed on a bi-weekly basis. Photographs shall be taken in such a way to include an area or directional landmark. A minimum of twenty overall general project photographs depicting the overall project activities shall be taken monthly. A photograph log shall be maintained throughout the project with the following information for each photo: photograph number, a brief description, date, job title, location or station of pipeline (if applicable), and direction of the view in the photograph. The CONTRACTOR shall submit a plan that illustrates how the photograph log will be organized for approval by the OWNER.

D. ENGINEER will approve the views to be taken and select the time at which they will be taken. All photographs need to be viewable (digital), otherwise they will not be allowed off-site (refer to paragraph 1.4.A). Views will vary depending on the Progress Schedule.

E. Provide interior and exterior photographs of each buried structure prior to installation. Provide a minimum of four internal views and four external views of each structure.

F. Submit aerial photographs of the site with Initial and Final Application for Payment. One oblique photograph shall be taken from each cardinal direction (North, South,

East, and West). Provide 2 copies of each. One copy for the ENGINEERS use and the other to be turned over to the OWNER.

1.3 PRINTS

A. Project photographs shall be maintained in the CONTRACTOR'S electronic project coordination software. If requested, CONTRACTOR shall provide color copies or print of the selected photographs to the ENGINEER or OWNER at cost.

B. Provide high quality 5-inch by 7-inch standard weight prints with a satin finish. Aerial photographs shall be at least 20 by 24-inches, standard weight prints with a satin finish.

C. Provide high quality digital photographs on CDs. The file format shall be "jpg". The digital photographs shall be provided in addition to the standard photographs required under Paragraph 1.3.C., above. Need to provide a file for all required under paragraph 1.2.A.

D. Provide interior and exterior photographs of each buried structure prior to burial. Provide a minimum of four internal views and four external views of each structure. One view shall be provided of each wall, detail, floor and top of structure.

E. Place the following information on the back of each print and on front for digital photographs:
   1. Date photograph was taken.
   2. Title of Project, WS #.
   3. Description of view shown in photograph.
   4. North Arrow reference.

1.4 PRE-CONSTRUCTION PHOTOGRAPHS

A. Policy
   1. Photography on facility grounds is strictly controlled. All personnel must submit a written application request to Water Services Department, Security Management Unit for photography and receive written permission. Application must include name of company, the photographer, and area of interest. If written application is not submitted prior to the commencement of photography activities, on-site security personnel will stop the activities, confiscate the media materials and notify the Security Management Unit.
   2. Once permission is received, the on-site security personnel and Security Management Unit must be notified before photos or videotapes are made.
   3. Prior to departing from the site, photographer must have the materials reviewed by either the Facility Supervisor or the O&M Supervisor. For media that's not readily viewable, such as film that needs to be developed, the photographer must allow the Facility Supervisor or O&M Supervisor to review the materials prior to any use of the materials.

B. General
   1. It is the CONTRACTORS responsibility to provide a minimum of fifty (50) pre-

construction photographs and video (if directed), so as to resolve any disputes which may arise regarding the considerations prior to and subsequent to construction. It is recommended to coordinate these photos with the ENGINEER who may take its own set of pre-construction photos.

2. If a dispute arises where no Pre-construction photographs were provided, the disputed area shall be restored to the extent directed by the ENGINEER and to the complete satisfaction of the ENGINEER.
3. Prior to the start of any construction activities the CONTRACTOR shall furnish (2) sets of color pre-construction photographs and video for approval; one for the ENGINEER and one for City of Phoenix.
4. Pre-construction photographs taken by CONTRACTOR will not be considered as part of the required number of construction photographs required in Paragraph 1.2, above.
5. A high quality video of the site in digital format shall be made and submitted by the CONTRACTOR.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Submittal of documents described in the General Conditions, Supplementary Conditions and hereinafter are required prior to, during and at the end of the construction period. The submittals shall conform to the requirements described in this Section and all referenced Sections or Articles.

1.2 GENERAL SUBMITTAL REQUIREMENTS

A. A submittal shall be made for each complete system. Piece-meal submittals will not be accepted.
B. Submittals requiring ENGINEER review only will be processed within 14 calendar days after receipt from CONTRACTOR. Submittals requiring ENGINEER and OWNER review will be processed within 14 calendar days after receipt from CONTRACTOR.
C. CONTRACTOR shall maintain a file of all approved submittal documents at the work site.
D. CONTRACTOR shall show his executed internal review and approval marking. Submittals which are received from sources other than through CONTRACTOR'S Office or which have not undergone CONTRACTOR review will be returned "Rejected".

1.3 PROCEDURE

A. Submit the following items within 14 days after the Notice to Proceed. Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01 33 10, Reference Forms.
   1. Preliminary Schedule of Values: Prepare and submit in accordance with Section 01 29 73, Schedule of Values.
   2. Preliminary Schedule of Shop Drawings and Sample Submittal in accordance with the General Conditions and Section 01 33 23.10, Shop Drawing Procedures.
   3. Preliminary Progress Schedule: Prepare and submit in accordance with Section 01 32 16.15, Construction Progress Schedule.
   4. Schedule of Values: Prepare and submit in accordance with Section 01 29 73, Schedule of Values.
   5. Submittal Schedule: Prepare and submit schedule of all Shop Drawings in accordance with Section 01 33 23.10, Shop Drawing Procedures.
   6. Monthly payment schedule.
   7. Maintenance of Plant Operations Schedule, in accordance with Section 01 14 16, Coordination with OWNER'S Operations.

8. Ninety-day Bar Chart Schedule: Prepare and submit a 90-day Bar Chart Schedule within 14 days, in accordance with Section 01 32 16.15, Construction Progress Schedule.
9. Progress Schedule: Prepare and submit a Progress Schedule within 14 days, in accordance with Section 01 32 16.15, Construction Progress Schedule.

B. Submit the following items at the Pre-construction Conference: Refer to Sections 01 33 23.10, Shop Drawing Procedures, and Section 01 52 13.10, ENGINEER'S Field Office.

C. Submittals Prior to Beginning the Work: Refer to the General Conditions and Supplementary Conditions of the Contract Documents.

D. Submittals During Construction: During progress of the construction, provide the following submittals in a timely manner to prevent any delay in the Work schedule:
1. Updates to Progress Schedule: Provide an assessment of Work progress in relation to the Progress Schedule in accordance with Section 01 32 16.15, Construction Progress Schedule.
2. Shop Drawings, Product Data and Samples: Submit Shop Drawings, product data and samples in accordance with Section 01 33 23.10, Shop Drawing Procedures, and as required in various Sections of the Contract Documents.
3. Progress Payments: Submit applications for partial payments as specified in the General Conditions. MBE/WBE Utilization Form, included in Section 01 33 10, Reference Forms, shall be submitted with each progress payment.
4. Request for Information: Submit a Request for Information (RFI), included in Section 01 33 10, Reference Forms, when any of the following are required: an interpretation of the Specifications; additional details; information not shown on the Drawings or in the Specifications; or clarification of discrepancies is needed. Retain one copy and submit an electronic PDF format copy to the ENGINEER for response. Once the RFI is commented on by the ENGINEER, an electronic PDF format copy will be forwarded to the OWNER.
5. Change Orders: Forms shown in Section 01 33 10, Reference Forms. A proposal for a Change Order may be submitted by CONTRACTOR in accordance with the General Conditions. The Change Order Proposal included in Section 01 33 10, Reference Forms, must be in writing and must include sufficient information to assess the need for a change in the Work, the Contract time or the Contract amount. Whenever the ENGINEER determines the need for a Change Order, a Request for Change Order Proposal Form included in Section 01 33 10, Reference Forms, will be issued to CONTRACTOR. Upon receipt of a Request for Change Order Proposal Form or when CONTRACTOR determines the need for a Change Order, prepare and submit three copies of a Change Order Proposal. The Change Order Proposal must be approved by CONTRACTOR, ENGINEER, and OWNER. When a Change Order Proposal has been accepted, a Work Change Directive shall be submitted. Each Work Change Directive shall include a Change Order Pricing Sheet, included in Section 01 33 10, Reference Forms. After the Work Change Directive has been accepted by the OWNER, a Change Order included in Section 01 33 10, Reference Forms, will be prepared and executed. CONTRACTOR is not authorized to begin work on a Change Order until it is fully executed. Any Work

done by CONTRACTOR prior to execution of a Change Order is entirely at his own risk.

6. Use of CONTRACTOR'S Contingency: Shown in Section 01 33 10, Reference Forms: Submit the CONTRACTOR'S Contingency Usage Request including a description for use of the contingency and costs associated for review by the ENGINEER and acknowledgement by the OWNER.
7. CONTRACTOR'S Daily Report: Shown in Section 01 33 10, Reference Forms: Submit four copies of CONTRACTOR'S Daily Report. CONTRACTOR and each subcontractor shall prepare and submit a daily report on forms shown in Section 01 33 10, Reference Forms. The report shall contain, as a minimum, information on the location and description of the Work being performed, size, quantity and description of materials and equipment installed or delivered, coordination or scheduling concerns, requests for clarifications, and any discrepancies noted in the Contract Documents or on the as-built conditions. The report shall also contain CONTRACTOR'S daily workforce count by craft, general weather conditions, any Work performed other than during established working hours, and any other pertinent items relative to the Work, and as required by ENGINEER. The report is due at the ENGINEER'S office by 9:00 a.m. on the following Work day and shall be signed by a responsible member of CONTRACTOR'S staff.
8. Submittal Schedule: Shown in Section 01 33 10, Reference Forms. Submit an updated Shop Drawing, Product Data and Sample Submittal Schedule with each Progress Payment Request. Three updated Submittal Schedules shall be submitted with each month's Progress Payment Request.
9. Construction Photographs: Submit Construction Photographs and Aerial Photographs with each month's Progress Payment Request as specified in Section 01 32 33, Photographic Documentation.
10. Operation and Maintenance Manuals and Lesson Plans: Submit Equipment Operation and Maintenance Manuals for approval, by the ENGINEER, within 30 days after approval of Equipment Shop Drawing. Submit Equipment Training Lesson Plans for approval, by the ENGINEER, 60 days prior to commencement of training. Submit Operation and Maintenance Data and Lesson Plans in accordance with Section 01 78 23, Operation and Maintenance Data and Section 01 79 00, Instruction of Operations and Maintenance Personnel.
11. Submit test procedures for Start up, Burn-in, Field Operations Checks and Commissioning a minimum of 30 days prior to commencement of the first scheduled test date. The CONTRACTOR should allow up to 14 days for ENGINEER'S review.
12. Submit preventive maintenance data associated with the equipment/asset shop drawing package at the same time as the shop drawing. The preventive maintenance data submittal requirement is further described in Section 01 78 23 – Operation and Maintenance Data.

E. Submittal at Substantial Completion: Submit all Operations and Maintenance Data for each item of Work commissioned into operation.

F. Submittal At Project Closeout: With a written Notice of Completion, submit the following items in the proper form as a condition of Final Acceptance of the Work:

1. Project Record Documents: Submit in accordance with Section 01 78 39, Project Record Documents.
2. Guarantees, Warranties and Bonds: Submit as required in the General Conditions and listed in various Sections of the Specifications, and Section 01 78 23, Operation and Maintenance Data.
3. Operations and Maintenance Data: Submit all remaining product data, field test data and manuals as specified in various Sections of the Specifications, and Section 01 78 23, Operation and Maintenance Data.
4. Survey notes.
5. Construction photographs of all completed Work, in accordance with Section 01 32 33, Photographic Documentation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 33 10

REFERENCE FORMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section contains the required forms for CONTRACTOR use in documenting testing Work and other Work required under this Contract. This Section supplements but does not supersede specific testing requirements found elsewhere in the Contract Documents.

B. The forms listed below are included in this Section are referenced from other Sections in the Contract Documents. Forms will include, but will not necessarily be limited to the list below. The forms provided indicate minimum requirements. If desired to use a supplemental form the document must be submitted for review and approval by the ENGINEER.

Form No.	Title
01 14 16-A	Extended Construction Work Hours Permit Application
01 32 16-A	Certificate of Substantial Completion
01 32 16-B	Contractor's Affidavit Regarding Settlement of Claims
01 33 00-A	Schedule of Values
01 33 00-B	Shop Drawings, Product Data and Sample Submittal Schedule
01 33 00-C	Authorized Signatures Form
01 33 00-D	Application for Payment
01 33 00-E	MBE/WBE Utilization Form
01 33 00-F	Request for Change Order Proposal
01 33 00-G	Change Order Proposal
01 33 00-H	Work Change Directive
01 33 00-I	Change Order Pricing Sheet
01 33 00-J	Change Order
01 33 00-K	Request for Information
01 33 00-L	Request for Alteration
01 33 00-M	Contractor's Daily Construction Report
01 33 00-N	TV Inspection Request
01 33 00-O	Contractor Submittal Review Checklist
01 33 00-P	Submittal Review Form
01 33 00-Q	Contractors Contingency Usage Request
01 33 23.10-A	Submittal Transmittal Form
01 33 23.10-B	Shop Drawing Review Checklist
01 35 24-A	Confined Space Data Sheet
01 35 24-B	Confined Space Entry Permit
01 35 24-C	Confined Space Hot Work Permit
01 73 19-A	Manufacturer's Installation Certification Form
01 73 19-B	Delivery Inspection Form
01 75 16-A	Equipment Test Report

01 78 23.19-A	Preventive Maintenance Data Submittal Form
01 78 23-A	Operating & Maintenance Manual Contractor Checklist
01 78 23-B	Operating & Maintenance Manual Engineer / PM Checklist
01 78 23-C	Operating & Maintenance IRS Checklist – TEMPLATE
01 78 23-D	Operating & Maintenance Binder Spines – TEMPLATE
01 78 23-E	Operating & Maintenance Cover/Title Page – TEMPLATE
01 78 23-F	Operating & Maintenance CD Label – TEMPLATE
01 78 43-A	Spare Parts Receiver Form
01 79 00-A	Manufacturer's Instruction Certification Form
01 79 00-B	Training Request Form
11 00 00-A	Equipment Information Form Instructions
11 00 00-A	Equipment Information Form
11 00 00-B	Unit Responsibility Certification Form
11 00 00-C	Equipment Manufacturer Vendor Installer Information Form
22 01 10.52-A	Request for Bacteriological Samples
26 05 01-A	Wire and Cable Resistance Test Data Form
26 05 01-B	Installed Motor Test Data Form
26 05 01-C	Dry Transformer Test Data Form
26 05 01-D	Motor Control Center Test Form
26 05 01-E	Medium Voltage Motor Starter Test Form
26 05 01-F	Medium Voltage Switchgear Test Form
26 05 01-G	Protective Relay Test Form
26 05 01-H	Low Voltage Switchgear Test Form
26 05 01-I	Medium Voltage Load Interrupter Switch Test Form
26 05 01-J	Liquid-Filled Transformer Test Form
26 05 01-K	Automatic Transfer Switch Test Form
26 05 01-L	Neutral Grounding Resistor Test
26 05 01-M	Conduit and Wire Termination Sheet
26 05 01-N	Ground Test Point Data Form
26 05 73-A	Power System / Arc Flash Analysis Sign-off Form
26 32 13.10-A	Add Generator to Fleet – Inspection Checklist
40 61 13-A	Instrument Tubing Leak Test Form
40 61 13-B	Calibration Test Data Form.
40 61 13-C	Functional Acceptance Test
40 67 00-A	Factory Acceptance Test Report
43 28 11-A	Motor Data Form
43 32 76-A	Contract Employee Training Checklist
43 32 76-B	Contract Employee Injury and Illness Log
43 33 00-A	Contract Employee Training Checklist
43 33 00-B	Contract Employee Injury and Illness Log

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 33 23.10

SHOP DRAWING PROCEDURE

PART 1 - GENERAL

1.1 DESCRIPTION

A. The submittal of Shop Drawings shall conform to requirements of General Conditions and procedures described in this Section. A separate transmittal form shall be used for each specific item or class of material or equipment for which a submittal is required. Transmittal of Shop Drawings on various items using a single transmittal form shall be permitted only when the items taken together constitute a manufacturer's "package" or are so functionally related that expediency indicates review of the group or package as a whole.

B. The term "Shop Drawings" as used herein shall be understood to include detailed design calculations, fabrication and installation drawings, lists, graphs, test data, operating instructions, preventive maintenance tasks instructions, and other items which shall include, but are not necessarily limited to:
   1. Drawings and catalog information and cuts.
   2. Specifications, parts list, suggested spare parts lists, and equipment drawings.
   3. Wiring diagrams of systems and equipment.
   4. Complete lubrication, preventive maintenance and operation instructions, including initial startup instructions as described in Section 01 78 23, Operation and Maintenance Data and Section 01 79 00, Instruction of Operations and Maintenance Personnel.
   5. Applicable certifications.
   6. Anchor bolt templates, mounting instructions and mounting design calculations as required.
   7. Required maintenance operations to allow all installed equipment to remain idle for a period of time not to exceed 24 months.
   8. Other technical, installation, and maintenance data as applicable.
   9. Unloading and handling methods and storage requirements.
   10. Note, highlight, and explain proposed changes to the Contract Documents.
   11. Paint submittal showing type of paint and the mils thickness of coating system used. The coating system shall be the approved system as submitted under Division 9, Finishes.
   12. Drawings showing CONTRACTOR field verifications illustrating all field dimensions.
   13. For materials or products which can contact drinking water as part of a Water Treatment Process or Water Supply System, submit certificate of compliance with NSF/ANSI 61 Standard or Arizona Administrative Code R18-4-119.

C. Preliminary Submittal Schedule: CONTRACTOR, within 7 days after the Notice to Proceed, shall prepare and submit to the ENGINEER a Preliminary Submittal Schedule. Identify on his Preliminary Submittal Schedule all of the submittal items required by the Contract Documents governing the Work.

D. Submittal Schedule: CONTRACTOR, within 14 days after the Notice to Proceed, shall prepare and submit to the ENGINEER a comprehensive Submittal Schedule. Identify on his Submittal Schedule all of the submittal items required by the Contract Documents governing his Work. Indicate, for each submittal item on his Submittal Schedule the following:
   1. The date by which that item will be submitted to the ENGINEER.
   2. Whether the submittal is for a substitute or "equal" item. Complete submittal for all substitute or "equal" items shall be made to the ENGINEER, in accordance with the Contract requirements. Identification by the CONTRACTOR of substitute or "equal" items does not relieve CONTRACTOR of his responsibility to furnish equipment and materials that meet all the requirements of the Contract Documents. Items of manufacturers' equipment listed with CONTRACTOR'S Bid Proposal shall not be replaced with any substitute or "equal" items as part of this Submittal Schedule process. Procedure for substitutions is specified under the General Conditions.
   3. Whether the submittal is for review or "for record only".
   4. The date by which response is required.
   5. The date by which the material or equipment must be on site in order not to delay the progress of the Work.

E. In preparing his Submittal Schedule, CONTRACTOR shall consider the nature and complexity of each submittal item and shall allow ample time for review, revision or correction. Submittal will normally be returned to CONTRACTOR within 14 calendar days following receipt of the submittal. Complex submittals, for example, Instrumentation and Control Systems, Variable Frequency Drives and other such submittals may require additional review time. CONTRACTOR shall identify submittal(s) for which long review periods are anticipated.

F. CONTRACTOR is hereby notified that the project electric motor requirements, specified in Section 43 28 11, Electric Motors 250 Horsepower or Less, do not allow standard "off the shelf" motors. CONTRACTOR shall make provisions in the Submittal Schedule to account for longer manufacturing and delivery lead times for the motors and equipment requiring electric motors under this Project.

G. The ENGINEER will review CONTRACTOR'S Submittal Schedule to determine its completeness and compatibility with the Progress Schedule. A Submittal Schedule which is incompatible with the Progress Schedule or a review schedule which places extraordinary manpower demands on the ENGINEER will be sufficient reason(s) to reject the Submittal Schedule. It shall be understood that certain submittals will take longer than 14 days to review and that these particular submittals will be identified during the review of the Submittal Schedule, by the ENGINEER to allow for very complex submittal reviews.
   1. CONTRACTOR'S Submittal Schedule shall be consistent with the Progress Schedule as described in Section 01 32 16.15, Construction Progress Schedule (CPM).
   2. Approval of the Submittal Schedule shall be required prior to processing of the first progress payment.
   3. Submit Shop Drawings for early deliverables items at the Pre-construction Conference. These include, but are not limited to the following:
      a. To be determined by CONTRACTOR

1.2 PROCEDURE

A. Submit Shop Drawings to: HDR Engineering, Inc. 20 E Thomas Rd., Suite 2500, Phoenix, AZ 85012.

B. A letter of transmittal shall accompany each submittal. If data for more than one Section of the Specifications is submitted, a separate transmittal letter shall accompany the data submitted for each Section.

C. All letters of transmittal shall be submitted in duplicate.

D. At the beginning of each letter of transmittal, provide a reference heading indicating the following:
   1. OWNER'S Name _____
   2. Project Name _____
   3. Contract No. _____
   4. Transmittal No. _____
   5. Section No. _____

E. If a Shop Drawing deviates from the requirements of the Contract Documents, specifically note each variation in his letter of transmittal.

F. All Shop Drawings submitted for approval shall have a title block with complete identifying information satisfactory to ENGINEER.

G. All Shop Drawings submitted shall bear the stamp of approval and signature of CONTRACTOR as evidence that they have been reviewed and verified to the completeness of the submittal by CONTRACTOR. Submittal without this stamp of approval will not be reviewed by ENGINEER and will be returned to CONTRACTOR. CONTRACTOR'S stamp contain the following minimum information:

Project Name: _____

CONTRACTOR'S Name: _____

Date: _____

----------Reference----------

Item: _____

Specifications:

Section: _____

Page No.: _____

Para. No.: _____

Drawing No.: _____ of _____

Location: _____

Submittal No.: _____

Approved By: _____

H. In order to identify and track all submittals as separate and unique items, utilize the submittal identification numbering system as follows:
   1. The Submittal Number shall be a separate and unique number correlating to each individual submittal that is required to be tracked as a separate and unique item. The Submittal Number shall be a two part, eight character, alpha/numeric number assigned by CONTRACTOR in the following manner:
      a. The first part of the Submittal Number shall consist of five characters that pertain to the applicable Specification Section number.
      b. The second part of the Submittal Number shall consist of three digits (numbers 001 to 999) to number each separate and unique submittal submitted under each Specification Section.
      c. A dash shall separate the two parts of the Submittal Number.
      d. A typical Submittal Number for the third Working Drawing submitted under Section 33 05 19, Ductile Iron Pipe, would be 33 05 23-003.
   2. The Review Cycle shall be a three-digit number indicating the initial submission or resubmission of the same submittal. For example:

      001 = First (initial) submission
      002 = Second submission (first resubmission)
      003 = Third submission (second resubmission)

   3. An example of the typical submittal identification numbers for the first submission of the third submittal submitted under Section 33 05 19, Ductile Iron Pipe is:

Submittal Number	Review Cycle
33 05 19-003	001

   An example of the typical submittal identification numbers for the second submission of the third submittal submitted under Section 33 05 19, Ductile Iron Pipe is:

Submittal Number	Review Cycle
33 05 19-003	002

I. Initially submit to ENGINEER Electronic PDF format copies.

J. After ENGINEER completes his review, Shop Drawings will be affixed with a stamp and marked with one of the following notations:
   1. Approved.
   2. Approved as Corrected.
   3. Approved as Corrected, Resubmit.
   4. Revise and Resubmit.
   5. Not Approved.
   6. Not Reviewed.
   7. For Information Only.

K. If a submittal is acceptable, the ENGINEER will mark it “Approved” or “Approved as Corrected” and will forward response via electronic PDF format of the submittal to the OWNER for review and comment. The OWNERS review process will begin when all required copies of a specific submittal are received. After the OWNERS review is complete, the ENGINEERS and OWNERS comments will be combined and an electronic PDF copy of the submittal will be returned to CONTRACTOR.

L. Upon return of a submittal marked “Approved” or “Approved as Corrected”, CONTRACTOR may order, ship or fabricate the materials included on the submittal, provided it is in accordance with the corrections indicated.

M. If a Shop Drawing marked “Approved as Corrected” has extensive corrections or corrections affecting other Shop Drawings or Work, ENGINEER may require that CONTRACTOR make the corrections indicated thereon and resubmit the Shop Drawings for record purposes. Such Shop Drawings will have the notation, “Approved as Corrected - Resubmit.” The corrected Shop Drawing shall be a pre-condition for payment for the work item of the Shop Drawing.

N. If a submittal is unacceptable, an electronic PDF copy will be returned to CONTRACTOR with one of the following notations:
1. “Revise and Resubmit”
2. “Not Approved”

O. Upon return of a submittal marked “Revise and Resubmit”, make the corrections indicated and repeat the initial approval procedure. The “Not Approved” notation is used to indicate material or equipment that is not acceptable. Upon return of a submittal so marked, repeat the initial approval procedure utilizing acceptable material or equipment.

P. Any related Work performed or equipment installed without an “Approved” or “Approved as Corrected” Shop Drawing will be at the sole responsibility of CONTRACTOR.

Q. Shop Drawings shall be submitted well in advance of the need for the material or equipment for construction and with ample allowance for the time required to make delivery of material or equipment after data covering such is approved. Assume the risk for all materials or equipment which are fabricated or delivered prior to the approval of Shop Drawings. Materials or equipment will not be included in periodic progress payments until approval thereof has been obtained in the specified manner.

R. ENGINEER will review and process all submittals promptly; a reasonable time shall be allowed for this, for the Shop Drawings being revised and resubmitted, and for time required to return the approved Shop Drawings to CONTRACTOR.

S. Responsibility belongs to CONTRACTOR to review submittals made by his suppliers and subcontractors before transmitting them to the ENGINEER to assure proper coordination of the Work and to determine that each submittal is in accordance with CONTRACTOR’S desires and that there is sufficient information about materials and equipment for ENGINEER to determine compliance with the Contract

Documents. Incomplete or inadequate submittals will be returned for revision without review.

T. Furnish required submittals with complete information and accuracy in order to achieve required approval of an item within one submittal. Backcharges for resubmittals that account for a number greater than 20 percent of the total number of first time submittals and will be backcharged for all third submittals. The number of first time submittals shall be equal to the number of submittals agreed to by ENGINEER and CONTRACTOR in accordance with Section 01 33 00.1.2.A.2. All costs to ENGINEER involved with subsequent submittal of Shop Drawings, Samples or other items requiring approval will be backcharged to CONTRACTOR at the rate of 3.0 times direct technical labor cost by deducting such costs from payments due CONTRACTOR for Work completed. In the event that CONTRACTOR requests a substitution for a previously approved item, all of ENGINEER'S costs in the reviewing and approval of the substitution will be backcharged to CONTRACTOR, unless the need for such substitution is beyond the control of CONTRACTOR.

U. The OWNER reserves the right to withhold monies, identified in the General Conditions, for Shop Drawing reviews beyond those described herein.

V. The ENGINEER will implement, if requested by CONTRACTOR, one special Shop Drawing Review Meeting. The purpose of the meeting is to expedite Shop Drawing reviews for the equipment and materials required for the first document of the Work. Requirements of this Section will not be waived, but could be expedited.

W. Mark each page of a submittal and each individual component submitted with the specification number, paragraph, and subparagraph. Arrange submittal information presentation to appear in the sequence in the Specification Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 33 23.15

SAMPLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The submittal of Samples shall conform to the requirements of the General Conditions and to procedures described in this Section.

B. Samples and Shop Drawings which are related to the same unit of Work or Specification Section shall be submitted at the same time. If related Shop Drawings and Samples are submitted at different times, they cannot be reviewed until both are furnished to the ENGINEER.

1.2 PROCEDURE

A. Review, approve, and submit all Samples promptly. Samples shall be identified with correct reference to Specification Section, page, article and paragraph number, and Drawing Number, when applicable. Samples shall clearly illustrate functional characteristics of the product, all related parts and attachments, and full range of color, texture, pattern and material. Samples shall be furnished so as not to delay fabrication, allowing the ENGINEER reasonable time for the consideration of the Samples submitted.

B. Submit at least three Samples of each item required for the ENGINEER'S approval. Submission of Samples shall conform to all applicable provisions under Shop Drawing Submittal and Correspondence Procedure. One of the Samples shall be delivered to the OWNER. The ENGINEER shall retain all samples. If CONTRACTOR requires a Sample for his use, he shall notify the ENGINEER, in writing.

C. Make all corrections required and shall resubmit the required number of new Samples, until approved.

1.3 JOB MOCK-UPS

A. See Divisions 3, 4, 7, 9, and 33 for mock-ups that must be collected.

1.4 SAMPLES FOR TESTS

A. Furnish such Samples of material as may be required for examination and tests. All Samples of materials for tests shall be taken according to standard methods and as required by the Contract Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 35 24

CONFINED SPACE ENTRY PLAN

PART 1 - GENERAL

1.1 DESCRIPTION

A. OWNER has determined that portions of the Work site may constitute “confined spaces” as defined in 29 CFR §1926.21(b)(2) and 1910.146. Accordingly, CONTRACTOR shall incorporate into its Safety Plan for the Work site appropriate measures to protect the health and safety of all persons on the Work site or who may be affected by the Work, including, without limitation thereby, employees and representatives of CONTRACTOR, any subcontractor, OWNER, or ENGINEER while they are present and engaged in the performance of their duties on the Work site.

B. Comply with all local, State and Federal rules and regulations related to the protection of persons working or entering into confined spaces including, but not limited to the following:
   1. 29 United States Code §654.
   2. Title 29 Code of Federal Regulations Parts 1910 and 1926, Occupational Safety and Health.
   3. Ariz. Rev. Stat. §23-403.
   4. City of Phoenix, Confined Space Program

C. To assure OWNER that CONTRACTOR is complying with the intent of the regulations stated in Paragraph 1.1.A, above, as they relate to the protection of all persons on the Work site, CONTRACTOR’S Safety Plan, at a minimum, respond to the following requirements as they relate to Work in confined spaces:
   1. Conducting a Site-specific hazard assessment to identify confined spaces that should be characterized as “Permit Required Confined Spaces” within the meaning of 29 CFR §1926.21 (b)(6)(i) and 29 CFR §1910.146.
   2. Adopting as an element of its Safety Plan appropriate requirements for safeguarding access to “Permit Required Confined Spaces”.
   3. Providing training, personal protective or safety equipment and personnel as needed to perform the Safety Plan’s requirements for “Permit Required Confined Spaces.”
   4. Performing all record-keeping required for “Permit Required Confined Spaces”, including the required permits and confined space data sheets located in Section 01 33 10, Reference Forms.

1.2 CONFINED SPACES SAFETY PLAN REQUIREMENTS

A. For purposes of the Safety Plan requirements listed in Article 1.1, above, “confined spaces” are those areas on or about the Work site that fall within OSHA’s definition as “any space having limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility

vaults, tunnels, pipelines, and open top spaces more than four feet in depth such as pits, tubs, vaults, and vessels."

B. Ensure that those persons who are required to enter a confined space are trained according to OSHA requirements set forth in 29 CFR §1926.21 (b)(6)(i).

C. If the confined space is a "Permit Required Confined Space", then comply with the standards set forth in 29 CFR §1910.146. and the City of Phoenix, Confined Space Program.

D. "Permit Required Confined Space" means a confined space that has one or more of the following characteristics:
   1. Contains or has the potential to contain a hazardous atmosphere.
   2. Contains a material that has the potential for engulfing an entrant.
   3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or floors, or by a floor that slopes downward and tapers to a smaller cross-section.
   4. Contains any other recognized serious safety or health hazard.

1.3 SUBMITTALS

A. Prepare and submit a site-specific Confined Space Entry Plan as a portion of the CONTRACTOR'S site-specific Health and Safety Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 41 27

EARTH MOVING AND DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall obtain all earthmoving permits and any other permits required for earthmoving and dust generating operations related to the Work as required by the Maricopa County Air Pollution Control Regulations.

B. CONTRACTOR shall not cause or allow any dust generating operation, earthmoving operation, use of property, or any other operation which causes fugitive dust emissions that exceed the 20 percent visible emission opacity limit in Rule 300 of Maricopa County's Air Pollution Control Regulations.

C. If requested by the OWNER, ENGINEER, or Maricopa County representative, CONTRACTOR shall conduct opacity observations for visible emissions of fugitive dust in accordance with techniques specified in USEPA Reference Method 9.

D. In addition to earthmoving permits, CONTRACTOR shall obtain an approved Dust Control Plan from Maricopa County. At a minimum, the Dust Control Plan shall include the following information:
   1. Name(s), address(es) and phone number(s) of the person(s) responsible for the preparation, submittal, and implementation of the Dust Control Plan and responsible for the dust generating operations.
   2. A site plan that describes the total area of land surface to be disturbed (in acres); the operations and activities to be performed on the site; actual and potential sources of fugitive dust emissions; and the delivery, transportation, and storage areas for the site (including types of materials stored and appropriate size of material stock piles).
   3. Description of the Reasonably Available Control Measures (RACM) to be applied during all periods of dust generating operations at all actual and potential sources of fugitive dust.
   4. Description of dust suppressants to be applied including product specifications; method, frequency, and intensity of application; type, number, and capacity of application equipment; and certifications related to the suppressant's appropriate and safe use.
   5. Description of specific surface treatment(s) or RACM used to control material track-out where unpaved or access points join paved surfaces.
   6. Description of at least one alternative RACM for each actual and potential fugitive dust source shall be designated as a contingency measure.

E. Post a copy of all earthmoving permits as well as the approved Dust Control Plan in a conspicuous location at the worksite and provide a copy of each to the ENGINEER.

F. CONTRACTOR shall maintain a daily written log that records the actual application or implementation of the RACMS described in the approved Dust Control Plan. Maintain this written log and supporting documentation on site and shall make available for review on request by ENGINEER, OWNER, or Maricopa County representative. Retain copies of the Dust Control Plan, RACM implementation records, and all supporting documentations for a minimum of three years.

G. At a minimum, CONTRACTOR shall provide all necessary equipment and materials to apply sufficient dust suppressants (e.g., water, etc.), properly clean (sweep, etc.) all track-out areas, and provide adequate physical stabilizations (e.g., gravel, recycled asphalt, etc.) to meet all requirements of the earthmoving permit and approved Dust Control Plan. Use these methods to control fugitive dust generation from all CONTRACTOR operations on all CONTRACTOR areas including, but not limited to:
   1. Construction areas.
   2. Vehicle and equipment parking areas.
   3. Material storage areas.
   4. Office and trailer areas.
   5. Haul and access roadways.
   6. Track-out areas.
   7. All other areas where CONTRACTOR work, storing, or parking of vehicles, equipment, and materials.

H. CONTRACTOR shall pay all fines issued to the OWNER by the USEPA, ADEQ, or Maricopa County due to violation of CONTRACTOR'S earthmoving permit and Dust Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 42 00

REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Definitions of basic Contract terms are included in the General Conditions.

B. Definitions of terms commonly found in the Specifications are as follows:
   1. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or to other paragraphs or schedules in the Specifications and similar locations in the other Contract Documents. Terms such as “shown”, “noted”, “scheduled”, and “specified” are used to help the user locate the reference. There is no limitation on the location.
   2. Installer (or applicator, or erector): An installer is CONTRACTOR or another entity engaged by CONTRACTOR, either as an employee or subcontractor to perform a particular construction activity, including installation, erection, application or similar operations. Installers are required to be experienced in the operations they are engaged to perform.
      a. The term “experienced”, when used with the term “installer”, means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with the requirements of authorities having jurisdiction and of the Supplier of the product being installed.
   3. Trades: Use of a term such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter”. It also does not imply that requirements specified apply exclusively to trades persons of the corresponding generic name.
   4. Assigned Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. Said specialists shall be engaged for those activities, and their engagement is a requirement over which CONTRACTOR has no option. These requirements shall not be interpreted to conflict with the enforcement of building codes and similar regulations governing the Work. Also, they are not intended to interfere with local trade-union jurisdictional settlements and similar conventions. Such assignments shall not relieve CONTRACTOR of its responsibility for fulfilling the requirements of the Contract Documents.
   5. Equipment Identification: Several terms define the information attached to equipment.
      a. The term “CMMS Tag” means information attached to equipment pertaining to the City of Phoenix Water Services Department Computerized Maintenance Management System. CMMS Tags shall be provided by the CONTRACTOR. Refer to Section 01 93 13.15,

Computerized Maintenance Management System Tags, for specifications regarding CMMS Tags.

b. The term “Manufacturer Nameplate” means information attached to equipment by the manufacturer pertaining to equipment criteria, such as capacity, power supply requirement, model number, etc.

1.2 ABBREVIATIONS

A. Common abbreviations, which may be found in the Specifications, are:

alternating current		AC
Ampere		A
ante meridiem		am
Average		avg.
biochemical oxygen demand		BOD
brake horsepower		BHP
British thermal unit		BTU
Centigrade		C
Company		Co.
cubic inch		cu. in.
cubic foot		cu. ft.
cubic yard		cu. yd.
cubic feet per minute		cfm
cubic feet per second		cfs
Decibel		DB
degree Centigrade (or Celsius)	(Say)	20°C
degree Fahrenheit	(Say)	68°F
Diameter		dia.
direct current		DC
Dollars		$
Each		ea
Efficiency		eff
Fahrenheit		F

feet per hour	fph
Feet	ft.
feet per minute	fpm
feet per second	fps
Figure	Fig.
Flange	flg
foot-pound	ft-lb
gallon	gal
gallons per minute	gpm
gallons per second	gps
gram	g
Hertz	Hz
horsepower	hp
hour	hr
inch	in.
inch-pound	in.-lb
inside diameter	id
kilovolt-ampere	kva
kilowatt	KW
kilowatt-hour	kwhr
linear foot	lin. ft.
liter	l
maximum	max.
mercury	Hg
milligram	mg
milligrams per liter	mg/l
milliliter	ml
millimeter	mm
million gallons per day	mgd
million gallon	mil

minimum	min.
National Pipe Threads	NPT
net positive suction head	npsh
number	No.
ounce	oz
outside diameter	OD
parts per million	ppm
post meridiem	pm
pound	lb
pounds per square inch	psi
pounds per square inch absolute	psia
pounds per square inch gage	psig
pounds per square foot	psf
revolutions per minute	rpm
second	sec.
specific gravity	sp gr
square	sq
square foot	sq ft
square inch	sq in
square yard	sq yd
standard	std
standard cubic feet per minute	scfm
total dynamic head	tdh
totally-enclosed-fan-cooled	tefc
volt	V

1.3 APPLICABLE CODES

A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards

shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Concrete Institute (ACI).
3. American Gear Manufacturers Association (AGMA).
4. American Institute of Steel Construction (AISC).
5. American Iron and Steel Institute (AISI).
6. American National Standards Institute (ANSI).
7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
8. American Society of Mechanical Engineers (ASME).
9. American Society for Testing and Materials (ASTM).
10. American Water Works Association (AWWA).
11. American Welding Society (AWS).
12. Concrete Reinforcing Steel Institute (CRSI).
13. Factory Mutual (FM).
14. Institute of Electrical and Electronics Engineers (IEEE).
15. National Electrical Manufacturer's Association (NEMA).
16. National Electrical Code (NEC) current adoption.
17. City of Phoenix – Amendments to the National Electric Code.
18. Occupational Safety and Health Administration (OSHA).
19. National Fire Protection Association (NFPA).
20. Prestressed Concrete Institute (PCI).
21. Underwriters' Laboratories, Inc. (UL).
22. All other applicable standards listed in the Specifications and the standards of utility service companies, where applicable.
23. Maricopa Association of Governments (MAG), Uniform Standard Specifications for Public Works Construction, as supplemented by the City of Phoenix. References to MAG Standard Details refer to the "Uniform Standard Details for Public Works Construction" sponsored and distributed by the Maricopa Association of Governments 1999, Arizona.
24. International Building Code, with City of Phoenix Amendments.
25. National Electric Code – NFPA 70, with City of Phoenix Amendments.
26. American Petroleum Institute (API).
27. Uniform Building Code as supplemented by the City of Phoenix, Building Construction Code.
28. International Energy Conservation Code, with City of Phoenix Amendments.
29. Phoenix Fire Code.
30. International Fuel and Gas Code, with City of Phoenix Amendments.
31. International Mechanical Code, with City of Phoenix Amendments.
32. Uniform Plumbing Code, with City of Phoenix Amendments.
33. International Plumbing Code (IPC), with City of Phoenix Amendments.
34. International Swimming Pool and Spa Code (ISPSC), with City of Phoenix Amendments.
35. International Green Construction Code (IGCC)
36. ASME Elevator Codes, with City of Phoenix Amendments.
37. National Sanitation Foundation (NSF-61) and Arizona Administration Code (AAC # 18-4-213)

a. Incorporate the requirements NSF-61, Drinking Water System Components Health Effects and AAC # 18-4-213, Standards for Additives, Materials and Equipment on all potable water systems, water treatment facilities and water distribution facilities.

B. To ensure consistent application of standards and codes the following terminology definitions shall be applicable throughout the contract documents.

Term	Definition
Phoenix Building Code	International Building Code with City of Phoenix Amendments
Phoenix Electrical Code	National Electric Code – NFPA 70 with City of Phoenix Amendments
Phoenix Energy Conservation Code	International Energy Conservation Code with City of Phoenix Amendments
Phoenix Fire Code	Phoenix Fire Code based on International Fire Code
Phoenix Fuel and Gas Code	International Fuel and Gas Code with City of Phoenix Amendments
Phoenix Mechanical Code	International Mechanical Code with City of Phoenix Amendments
Phoenix Plumbing Code	Uniform Plumbing Code with City of Phoenix Amendments
Phoenix Construction Code	All of the Codes Listed Above

1.4 OWNER'S REFERENCE SPECIFICATIONS

A. The Work, as may be otherwise specified, shall conform to the following Reference Specifications:
1. City of Phoenix, Specifications and Details for Public Works Construction, 2015 Edition
2. City of Phoenix, Supplemental Details, 2015 Edition
3. City of Phoenix, Supplement to the 2015 MAG Specifications, 2015 Edition

B. Maintain a complete copy of the Reference Specifications on the site.

1.5 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the

extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: For applicable publication dates, refer to General Conditions.

C. Conflicting Requirements: Where compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer to ENGINEER for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where standards are required to perform a required construction activity, obtain copies of same from the publication source.

E. Abbreviations and Names: Whenever in these Specifications or the other Contract Documents references are made to the standards, specifications, or other published data of international, national, regional or local organizations, such organizations may be referred to by their acronym or abbreviation only. The following acronyms or abbreviations, which may appear in the Specifications, shall have the meanings indicated herein.

1.	AA	Aluminium Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ACI	American Concrete Institute
6.	ACS	American Chemical Society
7.	AFBMA	Anti-Friction Bearing Manufacturers' Association
8.	AGMA	American Gear Manufacturers Association
9.	AI	Asphalt Institute
10.	AIChE	American Institute of Chemical Engineers
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMA	Acoustical Materials Association
16.	AMCA	Air Movement and Control Association

17.	ANSI	American National Standards Institute
18.	APA	American Plywood Association
19.	API	American Petroleum Institute
20.	APHA	American Public Health Association
21.	AREA	American Railway Engineering Association
22.	ARI	Air Conditioning and Refrigeration Institute
23.	ASA	American Standards Association
24.	ASAE	American Society of Agricultural Engineers
25.	ASTM	American Society for Testing and Materials
26.	ASCE	American Society of Civil Engineers
27.	ASHRAE	American Society of Heating, Refrigerating and Air Conditioning
28.	ASME	American Society of Mechanical Engineers
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPB	American Wood Preservers Bureau
32.	AWPI	American Wood Preservers' Institute
33.	AWS	American Welding Society
34.	AWWA	American Water Works Associations
35.	BHMA	Builders Hardware Manufacturers' Association
36.	CBMA	Certified Ballast Manufacturers' Association
37.	CDA	Copper Development Association
38.	CGA	Compressed Gas Association
39.	CISPI	Cast Iron Soil Pipe Institute
40.	CMAA	Crane Manufacturers' Association of America
41.	CRSI	Concrete Reinforcing Steel Institute
42.	EPA	Environmental Protection Agency
43.	ETL	Engineering Test Laboratories
44.	FCC	Federal Communications Commission
45.	FEMA	Federal Emergency Management Agency
46.	FGMA	Flat Glass Marketing Association

47.	FM	Factory Mutual Association
48.	FS	Federal Specification
49.	GA	Gypsum Association
50.	HEW	Department of Health, Education and Welfare
51.	HI	Hydraulic Institute
52.	HMI	Hoist Manufacturers' Institute
53.	HUD	Department of Housing and Urban Development
54.	ICBO	International Conference of Building Officials
55.	ICEA	Insulated Cable Engineers' Association
56.	IEEE	Institute of Electrical and Electronic Engineers
57.	IES	Illuminating Engineering Society
58.	IFI	Industrial Fasteners Institute
59.	IRI	Industrial Risk Insurers
60.	ISA	The Instrumentation Systems and Automation Society
61.	ISO	Insurance Services Office
62.	MAG	Maricopa Association of Governments
63.	MIA	Marble Institute of America
64.	MS	Military Specifications
65.	MMA	Monorail Manufacturers' Association
66.	NAAMM	National Association of Architectural Metal Manufacturers
67.	NACE	National Association of Corrosion Engineers
68.	NARUC	National Association of Railroad and Utilities Commissioners
69.	NBHA	National Builders Hardware Association
70.	NEC	National Electrical Code
71.	NEMA	National Electrical Manufacturers Association
72.	NESC	National Electrical Safety Code
73.	NFPA	National Fire Protection Association
74.	NHLA	National Hardwood Lumber Association
75.	NHPMA	Northern Hardwood and Pine Manufacturer's Association
76.	NLMA	National Lumber Manufacturers' Association

77.	NRCA	National Roofing Contractors Association
78.	NSF	National Sanitation Foundation
79.	NTMA	National Terrazzo and Mosaic Association
80.	NWWDA	National Wood Window and Door Association
81.	OECI	Overhead Electrical Crane Institute
82.	OSHA	Occupational Safety and Health Administration
83.	PCI	Precast Concrete Institute
84.	PEI	Porcelain Enamel Institute
85.	PPI	Plastic Pipe Institute
86.	PS	Product Standards Section-U.S. Department of Commerce
87.	RMA	Rubber Manufacturers' Association
88.	SAE	Society of Automotive Engineers
89.	SCPRF	Structural Clay Products Research Foundation
90.	SDI	Steel Deck Institute
91.	SDI	Steel Door Institute
92.	SIGMA	Sealed Insulating Glass Manufacturing Association
93.	SJI	Steel Joist Institute
94.	SMACNA	Sheet Metal and Air Conditioning National Association
95.	SPI	Society of the Plastics Industry
96.	SSPC	The Society for Protective Coatings
97.	SWI	Steel Window Institute
98.	TEMA	Tubular Exchanger Manufacturers' Association
99.	TCA	Tile Council of America
100.	UL	Underwriters' Laboratories, Inc.
101.	USGS	United States Geological Survey
102.	USPHS	United States Public Health Service
103.	WCLIB	West Coast Lumber Inspection Bureau
104.	WWEMA	Water and Wastewater Equipment Manufacturers Association
105.	WWPA	Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 29.10

ON- SITE FACILITIES FOR TESTING LABORATORY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide on-site facilities for the sole use of the testing laboratory.

B. Facilities furnished include:
   1. One continuously heated weathertight room, minimum ten feet square.
   2. One large, tightly constructed, firmly braced, insulated, wooden or steel box which will hold 20 concrete cylinders minimum under conditions as described in ASTM C 31, Making and Curing Concrete Test Specimens in the Field. The number, size and location shall be coordinated with the ENGINEER, and as necessary to provide the storage required for each day's concrete placement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 29.15

TESTING LABORATORY SERVICES FURNISHED BY OWNER

PART 1 - GENERAL

1.1 DESCRIPTION

A. The OWNER will, through the ENGINEER, employ and pay for an independent testing laboratory to perform the specified services. Material specific requirements for testing are indicated in the associated Specifications section under "Source Quality Control", "Field Quality Control" or "Quality Assurance" as appropriate for each material.

B. The OWNER will pay for the testing, except for repeat testing which results from CONTRACTOR'S negligence or his repeated failure to meet Contract Document requirements.

C. CONTRACTOR shall pay for:
   1. Tests not listed above.
   2. Tests made for CONTRACTOR'S convenience.
   3. Repeat tests required because of CONTRACTOR'S negligence or repeated failure, three or more tests for the same item, to meet Contract Document requirements.
   4. All other tests.

D. The testing laboratory is not authorized to approve or accept any portion of the Work; rescind, alter or augment the requirements of the Contract Documents; or perform any duties of CONTRACTOR.

1.2 QUALIFICATIONS OF LABORATORY

A. Where applicable, the testing laboratory will meet "Recommended Requirements for Independent Laboratory Qualification", latest edition, published by American Council of Independent Laboratories and the basic requirements of ASTM E 329 "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction".

B. Testing equipment used by the laboratory will be calibrated at maximum twelve month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.

1.3 LABORATORY DUTIES

A. The testing laboratory shall:
   1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
   2. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.

3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies of Work that are observed during performance of services.
4. Promptly submit five copies of reports of inspections and tests to ENGINEER, including:
    a. Date issued.
    b. Project title and number.
    c. Testing laboratory name and address.
    d. Date of inspection or sampling.
    e. Record of temperature and weather.
    f. Date of test.
    g. Identification of product and Specification Section.
    h. Location in Project.
    i. Type of inspection or test.
    j. Results of tests and observations regarding compliance with Contract Documents.
5. Perform additional tests and services, as required by OWNER.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. CONTRACTOR:
1. Cooperate with laboratory personnel and provide access to Work and to manufacturer's operations.
2. Provide to laboratory, preliminary representative samples of materials to be tested, in required quantities.
3. Furnish copies of product test reports.
4. Provide to the laboratory the preliminary design mix proposed for concrete and other material mixes that require testing by the testing laboratory.
5. Furnish labor and facilities:
    a. To provide access to Work to be tested.
    b. To obtain and handle samples at the site.
    c. To facilitate inspections and tests.
    d. For laboratory's exclusive use for storage and curing of test samples.
    e. Forms for preparing concrete test beams and cylinders.
6. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
7. Arrange with laboratory and pay for additional samples and tests required for CONTRACTOR'S convenience.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 29.20

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall employ and pay for an independent testing laboratory to perform the specified services. Laboratory selected shall be subject to approval by the ENGINEER. Material specific requirements for testing are indicated in the associated Specifications section under "Source Quality Control", "Field Quality Control" or "Quality Assurance" as appropriate for each material.

1.2 QUALIFICATIONS OF LABORATORY

A. Where applicable, meet “Recommended Requirements for Independent Laboratory Qualification,” latest edition, published by American Council of Independent Laboratories and the basic requirements of ASTM E 329, “Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction.” Laboratory shall be authorized to operate in the State of Arizona.

B. Submit a PDF report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards, for the most recent tour of inspection, with memorandum of remedies of any deficiencies reported by inspection.

C. Testing Equipment:
   1. Calibrated, at maximum 12-month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.
   2. Submit copy of certificate of calibration made by an accredited calibration agency.

1.3 LABORATORY DUTIES

A. Cooperate with ENGINEER and provide qualified personnel promptly on notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.

C. Promptly notify ENGINEER and CONTRACTOR of any irregularities or deficiencies of Work that are observed during performance of services.

D. Promptly submit five copies of reports of inspections and tests to ENGINEER, including:
   1. Date issued.
   2. Project title and number.
   3. Testing laboratory name and address.

4. Name and signature of inspector.
5. Date of inspection or sampling.
6. Record of temperature and weather.
7. Date of test.
8. Identification of product and Specification Section.
9. Location in Work.
10. Type of inspection or test.
11. Results of tests and observations regarding compliance with Contract Documents.

E. Perform additional tests and services as required to ensure compliance with the Contract Documents.

1.4 CONTRACTOR'S COORDINATION WITH LABORATORY

A. Cooperate with laboratory personnel, and provide access to Work and to manufacturer's operations.

B. Provide to laboratory representative samples of materials to be tested, in quantities required by the laboratory for testing.

C. Furnish labor and facilities:
1. To provide access to Work to be tested.
2. To obtain and handle samples at the site.
3. To facilitate inspections and tests.
4. For laboratory's exclusive use for storage and curing of test samples.
5. Forms for preparing concrete test beams and cylinders.

D. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.

E. Arrange with laboratory and pay for, additional samples and tests required for CONTRACTOR'S convenience.

1.5 PRODUCT TEST REPORTS

A. Furnish copies of product test reports where required by the Specifications or requested by ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 33

CODE REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following types of Work will be subject to Special Inspections, which may be performed by the ENGINEER or the OWNER-approved Resident Project Representative, or by such other special inspector as the OWNER may employ:
   1. High-Strength Bolting: During all bolt installations and tightening operations.
      a. Material verification of high-strength bolts, nuts, and washers.
      b. Frequency: During all bolt installations and tightening operations, and prior to being covered up or substantial completion.
      c. Exceptions:
         1) In bearing-type connections when threads are not required by design to be excluded from the shear plane, inspection prior to or during installation will not be required.
   2. Concrete - mandatory for slabs on grade, walls, suspended decking.
   3. Reinforcing Steel and Expansion and Control Joints
   4. Structural Welding.
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 PCT of complete joint penetration welds and 20 PCT of fillet welds with liquid dye penetrant or magnetic particle.
      c. Test 20 PCT of liquid dye penetrant tested complete joint penetration welds with ultrasonic or radiographic testing.
   5. Structural Masonry.
   6. Epoxy Anchors.
   7. Electrical Inspections.
   8. Polyvinyl Chloride Liner for Concrete.
   9. Structural Steel
   10. Open-Web Steel Joists and Joists Girders
   11. Soil and Earthwork

1.2 SPECIAL INSPECTOR

A. The Special Inspector shall be an OWNER-approved qualified person who shall demonstrate his competence to the satisfaction of the regulatory authorities for inspection of the particular type of construction or operation requiring special inspection.

1.3 DUTIES AND RESPONSIBILITIES OF SPECIAL INSPECTOR

A. The Special Inspector shall observe and accurately record the Work assigned to be certain it conforms to the Contract Documents.
B. The Special Inspector shall furnish signed/sealed inspection reports to the regulatory authorities, the ENGINEER and other designated persons. All discrepancies shall be brought to the immediate attention of CONTRACTOR for correction, then, if uncorrected, to the ENGINEER and regulatory authorities.

C. The Special Inspector shall submit a final signed/sealed report stating whether the Work requiring special inspection was, to the best of their knowledge, in conformance with the Contract Documents and the applicable workmanship provision of these codes.

1.4 PERIODIC SPECIAL INSPECTIONS

A. Some inspections may be made on a periodic basis and satisfy the requirements of continuous inspection, provided this periodic scheduled inspection is performed as outlined in the Contract Documents and approved by the regulatory authorities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 35

TESTING OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, material, tools, equipment and incidentals as shown, specified and required to clean, flush and test structures.
   2. The Work also shall include all labor and materials required to prepare a structure for testing, convey water to the testing location, perform the testing, and all labor and materials required to drain and dispose of water used for testing.

B. Hydraulic Structures Scheduled for Hydrostatic Testing: Clean and test the following structures:

Hydraulic Structure Number	Hydraulic Structure Service and Location
Wet Well	Containment area for sewage travelling into the site. Submersible pumps will then pump the sewage out of the wet well.

C. Water for Testing:
   1. Water for initial testing will be furnished by the OWNER.
   2. Provide all temporary piping, hose, valves, backflow preventors, appurtenances, and services required for testing.
   3. Convey the water to the testing location.
   4. Water for testing may be withdrawn from:
      a. 2 inch potable water line within the site
   5. Coordinate the maximum rate at which water may be withdrawn with the OWNER by preparing and submitting a MOPO . Provide on the withdrawal piping, downstream of the backflow preventor, a valve to control the rate of flow and a flow meter. The flow meter shall be calibrated within one year and field calibrated/verified prior to the date of its use, and its certification of calibration shall be submitted to the ENGINEER for approval.
   6. Cost of water for re-testing shall be paid by CONTRACTOR to OWNER at OWNER'S standard rates.

D. Testing and piping is specified under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

1.2 DEFINITIONS

A. The term "hydraulic structures" is defined as tanks, channels, and other structures through which liquid is conveyed or that hold liquid. Hydraulic structures include structures that are open to the atmosphere and structures with closed tops. Hydraulic structures, include but are not limited to, wet wells, junction chambers equalization tanks, storage tanks, treatment process tanks

such as grit chambers, clarifiers, aeration tanks, filter beds, contact tanks, and other channels or tanks as designated herein.

1. Excluded are structures where cleaning and testing are specified under other Sections or contracts.

1.3 SUBMITTALS

A. Provide written notice of the proposed testing schedule for a given structure for review by the ENGINEER and OWNER at least 14 days prior to the scheduled testing. Include proposed plans for water conveyance, control, and disposal. Testing will not commence without approval of ENGINEER.

B. Shop Drawings: Submit for approval the following:
   1. Cleaning procedures.
   2. Hydrostatic testing procedures, methods, equipment, coordination, and schedules.
   3. Report for each test.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary valves, bulkheads, and other water control equipment and materials, shall be determined by CONTRACTOR subject to the ENGINEER'S review. No materials shall be used which would be injurious to the construction or its future function.

PART 3 - EXECUTION

3.1 CLEANING

A. Cleaning Requirements:
   1. Remove all scaffolding, planks, tools, rags, dirt, debris, and material not part of the structure prior to testing.
   2. Thoroughly clean the walls, floors, and operating equipment by sweeping, high-pressure wash, scrubbing, or other methods approved by ENGINEER.
   3. Remove all water, dirt, or foreign material accumulated during cleaning from the hydraulic structure. Provide temporary pumps, piping, and facilities as required to discharge water from the cleaning operation in a manner approved by ENGINEER.
   4. Do not proceed with testing until ENGINEER has approved the results of the cleaning operation.
   5. Cleaning shall conform to the requirements of Section 01 74 00, Cleaning .

3.2 GENERAL FOR TESTING AND DISINFECTION

A. The following requirements apply:
   1. Each pipeline listed under Section 1.1.B shall be tested separately.

B. Hydraulic structures shall be free of visible leakage. Repair leaks in a manner subject to ENGINEER'S approval and in accordance with the Contract

Documents.

C. The structure shall be tested prior to the application of exterior coating systems and the installation of masonry block veneer, if applicable.

D. Release of water from structures, after testing shall be as approved by the ENGINEER.

3.3 HYDROSTATIC TESTING OF HYDRAULIC STRUCTURES

A. Analysis of data from hydrostatic tests of hydraulic structures shall be performed by CONTRACTOR in accordance with the requirements of ACI 350.1 and as specified herein. Supply all materials and labor to obtain the test data.

B. Prior to the start of hydrostatic testing, the following shall be met.
   1. All elements of the structure that will resist pressure exerted by the retained liquid shall be in place and at specified strength levels. Concrete shall be fully cured.
   2. Structure walls shall not be backfilled and, if damp proofing is specified, coated with damp proofing prior to leakage testing, unless otherwise approved by ENGINEER.
   3. All valves, gates, blind flanges, and other items, other than concrete, that control the flow of or otherwise retain the liquid contents of the structure, shall be checked for water-tightness. If not watertight, provide measures to ensure water-tightness during the hydrostatic test.
   4. Defective concrete shall be repaired.
   5. Notify ENGINEER and OWNER a minimum of 48 hours prior to the start of filling of the structure for hydrostatic testing.
   6. Concrete hydraulic structures shall remain filled with clean water for an initial 48-hour period to allow for adsorption. Following this initial period, add make-up water to fill the hydraulic structure to the specified water surface test elevation.

C. Fill the hydraulic structure with clean water to the maximum water surface test elevation specified. Where no test elevation is specified and fluid level in the structure will normally be controlled by a weir, fill the structure to an elevation 6-inches below the weir crest. Where no test elevation is indicated and the structure does not have a flow control weir, the test elevation shall be two feet below the top of the structure.

Hydraulic Structure Number	Hydraulic Structure Service and Location	Water Surface Elevation for Testing
1	Wet well	Test to maximum operating level

D. Filling Hydraulic Structures with Water:
   1. Fill the portion of the hydraulic structure to be tested at a rate not to exceed two vertical feet per hour.
   2. During filling, provide a backflow preventor at the point where water is withdrawn from the existing potable water system, if applicable.

E. After water has been brought to the test elevation and the specified wetting period has elapsed, inspect the exposed surfaces of the structure for leakage. Repair locations where leakage or weeping is evident prior to the start of hydrostatic testing.

F. Hydrostatic test duration shall be determined by the ENGINEER based on ACI 350.1, but shall not be less than 24 hours.

G. Allowable Leakage:
   1. Leakage is defined as the quantity of water that must be supplied to the hydraulic structure or any section thereof to maintain the water level within 3-inches of the specified water surface test elevation during the hydrostatic test, plus the amount of water required to fill the hydraulic structure to the specified water surface test elevation at the conclusion of the hydrostatic test, plus precipitation, minus an allowance for evaporation if applicable.
   2. For concrete structures without lining of interior wetted surfaces, the allowable leakage is 0.075 percent of the volume tested per 24-hour period.
   3. For concrete structures with interior wetted surfaces lined with a waterproof material, the allowable leakage is 0.050 percent of the volume tested per 24-hour period.

H. Measurement Locations:
   1. Structures or structure cells that are less than 1,000 square feet in water surface area shall have measurements of water level taken at a minimum of two locations that are approximately 180 degrees apart.
   2. Structures or structure cells that are greater than 1,000 square feet in water surface area shall have measurements of water level taken at a minimum of four locations that are approximately 90 degrees apart.
   3. Each measurement location shall be marked and given a reference number. A reference point shall be marked on the face of the wall above the test water surface in a manner that will prevent movement or deterioration of the reference point mark during the test.
   4. Measurement locations shall be located so that the effects of wave action and wind are minimized.

I. Evaporation and Precipitation Measurement:
   1. In hydraulic structures that are open to the atmosphere, a clear plastic calibrated open-topped container not less than 18-inches in diameter and depth shall be partially filled, floated in the tank, and held in position near each measurement location. Calibration increments shall be 0.1-inch or less.
   2. Containers shall be located so that they are not shaded by the structure's walls, and are away from overhead items such as beams, pipes, and walkways.

J. Test Measurements:
   1. Do not start hydrostatic tests when severe weather conditions, such as heavy precipitation, high winds, major changes in average daily temperature, and other severe conditions are predicted.
   2. Record the following measurements at each test location at the start of the test period and at 12-hour intervals thereafter.

a. Distance from reference point to test water surface.
b. Depth of water in the evaporation-precipitation containers.
c. Temperature of the test water at a point 18-inches below the water surface.
d. Temperature of the water in the evaporation-precipitation containers at mid-depth.

3. If the water surface is subject to wave action at the measurement location, the average water surface elevation of the wave oscillations shall be recorded as the data.
4. The change in the water surface elevation at each measurement location shall be averaged and adjusted as follows:
   a. The total change in the hydraulic structure's water surface elevation shall be adjusted by the average change in water surface elevation in the evaporation-precipitation containers.
   b. Where the averaged water temperature measurements vary by more than 3 degrees from start to completion of the test period, adjustment in the test volume shall be determined by the change of the density of water resulting from the change in the average water temperature.
5. Determination of Leakage:
   a. Provide a test container filled with a known quantity of water at the start of the test. Attach the test pump suction to the test container.
   b. Pump water from the test container into the hydraulic structure with the test pump to maintain the water level in the hydraulic structure within 3-inches of the specified test elevation for the duration of the test period.
   c. At the conclusion of the test, pump water from the container into the hydraulic structure to attain the specified test elevation.
   d. Measure the water remaining in the container and record the amount used during the test on the test report.

K. Criteria for Acceptance:
1. The hydrostatic test will pass if the measured leakage is less than the allowable leakage and no leaks or weeping are observed.
2. The hydrostatic test shall be considered to have failed if the allowable leakage is exceeded or if leakage or weeping is observed.
3. If the test becomes unreliable due to excessive precipitation or other external factors, the test shall be re-started.
4. If a hydrostatic test fails, the structure may be re-tested immediately without repairs if approved by the ENGINEER. If the subsequent hydrostatic test fails, repair probable areas of leakage and repeat the hydrostatic test.
5. Re-test the structure until it meets the specified criteria for acceptance. Repair probable leakage areas before testing.

L. Reuse and Disposal of Water Used in Hydrostatic Tests:
1. Obtain written approval of the ENGINEER before water used in one hydrostatic test is pumped to a different hydraulic structure for reuse in a subsequent test.

M. The hydraulic structure shall not be backfilled or damp-proofed until acceptance of the hydrostatic test by the ENGINEER.

3.4 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested as specified in applicable Sections.

+ + END OF SECTION + +

SECTION 01 51 13

TEMPORARY ELECTRICITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary electrical service shall be provided by CONTRACTOR until Final Acceptance of the Work, unless otherwise agreed by ENGINEER.

B. All costs, including the charge for power consumed, shall be assumed by CONTRACTOR. Also, provide power for testing, initial start-up and commissioning of equipment.

C. The temporary service shall conform to applicable provisions of Divisions 26 and 33.

D. Materials and equipment may be new or used; however, they shall be in first class, fully serviceable condition and shall not create unsafe conditions or violate requirements of applicable codes.

E. Service is required for lighting, power tools, construction trailers, dewatering equipment, and similar usages. Electric space heaters and large welding machines are not included herein.

F. All temporary service required beyond the specified locations shall be the responsibility of CONTRACTOR requiring such power, who shall furnish his own portable generator or other means.

1.2 POWER SOURCE AND SERVICE REQUIRED

A. A temporary power service is available from Salt River Project (SRP).

B. System shall be 240/120 volt, single phase, 60 Hz with sufficient capacity to provide service for construction use by all trades and with the following minimum facilities:
   1. 300 ampere frame with 200 ampere trip primary circuit breaker.
   2. Two pole safety switch, and a 240/120 volt, single phase, 3 wire distribution panel.

C. Service shall be provided and maintained so that power can be secured at any desired point with no more than a 50-foot extension.

D. One power center, minimum, shall be provided on each floor.

E. Provide each outlet with circuit breaker protection and comply with ground fault protective requirements of NEC.

F. Work hours are specified under the General Conditions.

G. Provide continuous power for construction site offices.

H. Provide power to maintain continuous operation of existing facilities during changeover of electrical equipment.

I. Provide power for testing, checking, initial start-up of equipment and commissioning.

1.3 INSTALLATION

A. Install temporary work in a neat orderly manner and make structurally and electrically sound throughout.

B. Maintain installation throughout construction period to provide continuous service and to provide safe working conditions.

C. Modify service and rearrange wiring as Work progress requires.

D. Locate all facilities to avoid interference with hoisting, materials handling, storage, traffic areas, existing operable facilities and Work under other contracts.

E. Assume responsibility for and return to original condition any part of the permanent electrical system that is used for construction purposes.

1.4 REMOVAL

A. Completely remove temporary materials and equipment after permanent installation is in use.

B. Repair damage caused by the temporary service or its removal and restore to specified or original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 51 16

TEMPORARY FIRE PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Conform to the fire protection and prevention requirements specified herein as well as those which may be established by federal, state or local governmental agencies.

B. Comply with all applicable provisions of NFPA Standard No. 241, Safeguarding Building Construction and Demolition Operations.

C. Facilities specified herein shall be provided by CONTRACTOR, but all other contractors shall conform to the provisions of this Section and all applicable laws, ordinances, rules and regulations.

1.2 REQUIRED FIRE FIGHTING EQUIPMENT

A. Provide portable fire extinguishers, rated not less than 2A or 5B in accordance with NFPA Standard No. 10, Portable Fire Extinguishers, for each temporary building and for every 3000 square feet of floor area under construction.

B. Locate portable fire extinguishers 50 feet maximum from any point in the protection area.

1.3 FIRE PREVENTION AND SAFETY MEASURES

A. Prohibit smoking in all hazardous areas and in all of the OWNER'S buildings. Post suitable warning signs in areas which are continuously or intermittently hazardous.

B. Use metal safety containers for storage and handling of flammable and combustible liquids.

C. Do not store flammable or combustible liquids in or near stairways or exits.

D. Maintain clear exits from all points in the Work site.

1.4 COSTS OF INSTALLATION

A. Pay all costs including installation, maintenance, and removal.

1.5 HAZARDOUS MATERIALS RELEASE EVACUATION

A. Be familiarized with the OWNER'S hazardous materials release evacuation plan and shall have the Work force prepared to evacuate should the emergency occur.

B. The OWNER will conduct a training session for CONTRACTOR'S supervisory staff, which would be responsible to train all of CONTRACTOR'S employees, all Subcontractors' employees or any other personnel who are on site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 51 36

TEMPORARY WATER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary water shall be provided by CONTRACTOR, as specified in the paragraphs below.

1.2 DESCRIPTION OF SYSTEM

A. Furnish and install temporary water service for entire Project for use throughout construction period.

B. Provide water hoses from hose bibbs to point of operations.

C. Also, provide water for sanitary facilities, first aid facilities, fire protection, field offices, cleaning, disinfection and testing.

D. Maintain adequate volume of water for all purposes.

E. Potable Water Source:
   1. Supplier: Provide water source by connecting to existing utility mains at locations designated by OWNER. Provide backflow preventers, where required. Hydrants cannot be taken out of service.
   2. Provide minimum 1-inch supply service and supply and install meter satisfactory to water utility.
   3. Permission shall be obtained from OWNER for water from hydrants.

F. Maintain strict supervision of use of temporary services:
   1. Enforce conformance with applicable codes and standards.
   2. Enforce sanitary practices.
   3. Prevent abuse of services.
   4. Prevent wasteful use of water.
   5. Protect system from freezing.

1.3 COSTS OF INSTALLATION AND OPERATION

A. Pay costs of temporary water service, including costs of installation, maintenance and removal of pipe and equipment.

B. Pay costs for water used by all trades.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Obtain and pay for permits, fees, deposits required by governing authorities.

B. Obtain and pay for temporary easements required across property, other than that of OWNER.

C. Comply with federal, state and local laws, ordinances, rules and regulations and standards, and with utility service company regulations.

1.5 USE OF OWNER'S EXISTING SYSTEM

A. Use existing system for temporary water for construction.

B. Modify and extend system as necessary to meet temporary water requirements.

C. Upon completion of Work, restore existing system to specified, or original condition.

1.6 MATERIALS

A. Comply with applicable provisions of all respective Divisions.

B. Materials may be new or used, but must be adequate for purpose required, sanitary, and must not violate requirements of applicable codes.

C. Provide all required facilities, including piping, valves, pumps, pressure regulators, tanks and other appurtenances.

D. All materials or products which can contact drinking water shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with Arizona Administrative Code R18-04-119, Standards for Additives, Materials, and Equipment.

1.7 INSTALLATION

A. Install Work in a neat and orderly manner and make structurally and mechanically sound throughout.

B. Maintain to provide continuous service.

C. Modify and extend service as Work progress requires.

D. Locate piping and outlets to provide service convenient to work stations and to avoid interference with traffic and work areas, materials handling equipment, storage area, and work under other contracts.

E. Do not run piping on floor or on ground.

F. Provide drip pan under each hose bibb located within building, and connect drain to sewer.

G. Provide insulation, or other means, to prevent pipes from freezing.

H. When necessary to maintain pressure, provide temporary pumps, tanks and compressors.

I. Disinfect temporary potable water piping prior to use in accordance with City, State and Maricopa Association of Governments (MAG) requirements and as supplemented by the City of Phoenix.

1.8 REMOVAL

A. Completely remove temporary materials and equipment upon completion of construction.

B. Clean, repair damage caused by installation, and restore to specified or original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 52 00

TEMPORARY CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.1 GENERAL

A. CONTRACTOR is responsible for all temporary construction facilities required for the Work. CONTRACTOR shall make all arrangements with utility service companies for temporary services and shall pay all costs associated therewith.

B. Temporary construction facilities include:
   1. Water.
   2. Electricity and Lighting.
   3. Telephone.
   4. Heat, Weather Protection and Ventilation.
   5. Fire Protection.
   6. Sanitary and First Aid Facilities.

C. Abide by all rules and regulations of the utility service company or authority having jurisdiction.

D. Sufficient temporary heat and ventilation shall be provided to assure safe working conditions and that no damage will occur to any of the Work. In addition, all enclosed areas shall be maintained at a minimum of 50° F, unless otherwise specifically accepted in the Specifications.

E. Provide all materials, equipment and power required for temporary electricity and lighting. Include continuous power for construction site offices. Provide all outlets with circuit breaker protection and comply with ground fault protection requirements of NEC. Minimum lighting shall be five-foot candles for open areas, ten-foot candles for stairs and shops. Provide minimum of one 30- watt lamp each 20 feet in Work areas.

F. Suitably enclosed chemical or self-contained toilets shall be provided for the use of general employees. Toilets shall be located near the Work site and secluded from observation insofar as possible. Toilets shall be serviced at regular intervals, kept clean and supplied throughout the course of the Work.

G. Furnish and maintain a safe drinking water supply readily available to all workers.

H. Responsible for all utility service costs until Final Acceptance of the Work. Included are all fuel, power, light, heat and other utility services necessary for execution, completion, testing and initial operation of the Work.

I. CONTRACTOR:
   1. Comply with applicable requirements specified in Mechanical and Electrical Divisions.
   2. Maintain and operate systems to assure continuous service.

3. Modify and extend systems as Work progress requires.
4. Completely remove temporary materials and equipment when their use is no longer required.
5. Clean and repair damage caused by temporary installations or use of temporary facilities.
6. Restore existing facilities used for temporary services to specified or to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 52 13.10

ENGINEER'S FIELD OFFICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish, install, and maintain the field office, furnishings, and equipment for ENGINEER. Locate office near CONTRACTOR'S office in a location approved by ENGINEER. Provide office complete within 2 weeks after the Notice-to-Proceed.

B. Allocate 2 reserved parking spaces marked for use by the ENGINEER and OWNER. Reserved parking spaces shall be adjacent to ENGINEER'S field office and shall be graded and paved.

C. The office shall be separate from all CONTRACTOR'S offices.

D. Pay for any permits that may be required.

E. Complete layout of office shall be submitted to the ENGINEER for approval.

F. Erect a sunshade roof and raised wood platform. The roof shall be weathertight. The roof and platform shall extend for the full length of the trailer.

G. Field office security shall be the responsibility of CONTRACTOR. Deliver 10 field office door keys and all furniture keys to ENGINEER upon installation of field office to site.

1.2 MINIMUM CONSTRUCTION

A. Mobile office trailer in first class, condition acceptable to ENGINEER, which is specifically designed for this type of use and conforms to requirements above and below. Provide trailer by Pac-Van, GE Modular Space, or approved equal.

B. Concrete or boardwalk steps, landings and sidewalks of four feet minimum width for complete access to field office. Access to the office must comply with ADA (Americans with Disabilities Act) Standards, as applicable. Access doors shall be furnished with locking security bar doors as approved by the ENGINEER.

C. Completely weather tight and insulated.

D. Exterior finish acceptable to ENGINEER.

E. All interior finishes acceptable to ENGINEER.

F. Resilient floor covering and carpet in first class, new condition.

G. Area: 700 square feet minimum consisting of 2 offices**,** conference room, kitchen, lavatories and work areas. Interior layout shall be as directed by the ENGINEER.

H. Windows: Ten percent of floor area with operable sash and screens. Windows shall be furnished with locks and exterior security bars approved by the ENGINEER. All windows shall be equipped with operable venetian blinds. All offices shall be furnished with a window.

1.3 MINIMUM SERVICES

A. Interior lighting of 50 foot candles at desktop height.

B. Exterior light at entrance(s) and at parking areas.

C. Automatic heating to maintain 75°F in winter. Furnish and pay for all fuel/electric.

D. Automatic cooling to maintain 70°F in summer. Furnish and pay for all fuel/electric.

E. Continuous electric service required and pay all charges.

F. A minimum of 12 electric duplex receptacle wall outlets that are accessible from six feet along any wall..

G. Provide continuous high speed Internet service and DSL service with all associated equipment (maximum 4 weeks after Notice to Proceed), and configure Internet and DSL so service is available by all workstations DSL so service is available by all workstations.

H. Supply bottled water and cups as required for the duration of the Contract.

I. Private sanitary facilities with one water closet, one lavatory, with hot and cold running water, medicine cabinet with mirror, one tissue paper holder and one paper towel holder. Supply tissue paper, hand soap and paper towels as required for the duration of the Contract.

J. All plumbing facilities and sewers required in accordance with local codes. Protect from freezing.

K. One new copy machine, with document feeder, or approved equal, with scanning, reduction, enlargement, auto-document feed, auto stapler function, high capacity feeder, bypass tray, four paper trays, top tray, stacker tray , two-sided copying and sorting capability. Provide service, warranty (including toner and replacement cartridges) and maintenance for the duration of the Contract. Provide 8-1/2-inch by 11-inch, 8-1/2-inch by 14-inch, and 11-inch by 17-inch copy paper for the duration of the Contract. Copier shall make up to 11-inch by 17-inch copies. Copier shall copy at a rate no slower than 40 copies per minute.

L. Potable water hose bibb with 20 feet of hose and nozzle connected to potable water supply near main entrance to ENGINEER'S trailer.

M. For parking lot security lighting: Provide two pole mounted fixtures, 1000W each with photo cell control. Location to be determined by ENGINEER.

1.4 MINIMUM FURNISHINGS (NEW)

A. Field Office Furniture: Lease (or purchase) and install the following equipment for the duration of the Contract:
   1. Furnishings for each individual office, 2 offices total:
      a. One desk, 36-inches wide by 72-inches long table top with locking lap and 5-side drawers.
      b. Laptop computer docking station, 36" widescreen LCD monitor, wireless keyboard and mouse and power strip.
      c. One 30-inches by 72-inches folding table.
      d. One 4-drawer locking legal size filing cabinet.
      e. One 6-shelve bookcase, 36-inches wide by 84-inches high by 12-inches deep.
      f. One cushioned swivel arm chair and two cushioned folding chairs.
      g. One 48-inches by 36-inches liquid marking board with two sets of compatible markers (six colors and one eraser per set).
      h. One standard size wastepaper basket.
   2. Furnishings to be provided with conference room shall include:
      a. Two 30-inches by 96-inches folding tables.
      b. Two 30-inches by 72-inches folding tables.
      c. Twenty upholstered executive high-back chairs with cushioned seat and back, five-star base, wheels, arms, swivel, tilt control conference chairs.
      d. Two 48-inches by 60-inches liquid marking board with two sets of compatible markers (four colors and one eraser per set).
      e. One 48-inches by 60-inches cork bulletin board.
      f. One metal plan rack roller mounted, with 12 top mounted swivel type plan holders for 36-inches by 24-inches plan sheets.
      g. Two standard size wastepaper baskets.
   1. Furnishings to be provided with Kitchen area shall include:
      a. One, new GE minimum 12 cubic feet, frost-free, refrigerator with freezer, or approved equal. Refrigerator shall become property of OWNER upon completion of Contract.
      b. Ten-pound ABC approved fire extinguishers (number as required by Phoenix Building Code).
      c. One OSHA approved first aid kit, Johnson & Johnson Model No. 8161, or approved equal.
      d. One standard size wastepaper basket.
      e. One, new microwave oven, 0.9 cu.ft. size. Microwave oven shall become property of OWNER upon completion of the Contract.
      f. One base cabinet with sink and counter top.
   2. Furnishings to be provided in the toilet area shall include:
      a. One 15-gallon electric water heater (220 volt).
      b. One water closet accessible to handicap with grab bars.
      c. One toilet paper and paper towel dispenser.
      d. One 8-inch ceiling mounted exhaust fan, 60 cfm, Marlite.
      e. Vinyl cove base on wall.
      f. One wastebasket.
      g. Provide paper products and sanitizing soap for the duration of the Contract.

B. Smoke detectors (Phoenix Building Code A.R.S. 36-1637).

C. Identifying exterior sign, professionally lettered, at least 24-inches by 36-inches, with wording acceptable to ENGINEER.

D. Maximum-Minimum outdoor thermometer mounted in shade, but visible for easy reading from inside office. Location to be determined by ENGINEER. Provide Fischer Scientific Model No. 15-091, or approved equal.

E. Three battery operated clocks, wall mounted.

F. Lockable closet for storing instruments and bathroom supplies.

G. Walk-off mats at all entrances.

H. The computer network shall be connected to the internet via a partial T1 line that is capable of Virtual Private Network access through the internet. The speed of the T1 shall be a minimum of 10 Mbps.

I. Furnish office supplies, consumables, and service contracts for office and communications equipment for the duration of the Contract.

1.2 MAINTENANCE

A. Continuous maintenance of office and services. Cleaned not less than once per week.

B. Provide soap, paper towels, toilet tissues, cleansers, sanitary supplies, janitorial service (including vacuuming, washing floors, and cleaning toilets weekly) and implements.

C. Repair immediately any damage, leaks or defective service.

D. Maintenance shall be for the duration of the Contract.

E. Provide maintenance contract for the items described in Paragraphs 1.3.I., 1.3.K., 1.4.H. and 1.6 for the duration of the Contract. Also, provide a 24-hour response, service contract, for equipment with a minimum of eight hours pre-paid service per month.

1.3 PROVISIONS

A. All items shall be furnished and maintained by CONTRACTOR from the Notice to Proceed to the date of Final Acceptance. The cost of these items shall be considered incidental to the cost of the Project. No separate measurement of payment shall be made for these items.

1.4 REMOVAL

A. The office, together with the equipment, furnishings and facilities thereof, except miscellaneous small supplies shall become the property of CONTRACTOR and shall

be removed from the site of the Work upon OWNER Acceptance of the Project or when directed by ENGINEER.

B. At the completion of the Project, the computer systems and filing cabinets and filing cabinet contents shall become the property of the OWNER. All title for software and hardware shall be transferred to the OWNER.

C. At the completion of the Project, the ENGINEER and OWNER will return field office keys to CONTRACTOR.

D. Remove underground installations to minimum depth of 24-inches and grade to match surrounding conditions.

E. Restore existing facilities used during construction to specified or original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 52 13.15

CONTRACTOR'S FIELD OFFICES AND SHEDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide a CONTRACTOR'S field office with the minimum facilities specified. Provide all required storage and work sheds.

B. Field Office and Furnishings:
   1. As required by CONTRACTOR, but with sufficient room for project meetings.
   2. Include conference table and chairs sufficient for 20 persons.
   3. Telephone service.
   4. Twelve protective helmets for visitor's use.
   5. Exterior identifying sign.
   6. Other furnishings at CONTRACTOR'S option.
   7. Company sign no larger than 4-feet by 8-feet.

C. Provide one set of all Contract Documents in the office for ready reference at all times by interested parties.

D. Storage and Work Sheds:
   1. Provide storage and work sheds sized, furnished, and equipped to accommodate personnel, materials and equipment involved, including temporary utility services.

E. Remove office and sheds upon Final Acceptance, unless otherwise approved by ENGINEER.

F. Pay for any and all permits that may be required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 52 16

TEMPORARY SANITARY AND FIRST AID FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary sanitary and first aid facilities shall be provided by CONTRACTOR.

B. Provide temporary sanitary and first aid facilities for use throughout the Contract including:
   1. Potable water and sanitary drinking cups.
   2. Sanitary drinking fountains, where feasible.
   3. Enclosed toilet facilities.
   4. Suitable general employee washing facilities.
   5. First aid stations at or immediately adjacent to all major Work areas and in the temporary field offices.
   6. Post telephone numbers of physicians, hospitals and ambulance services by each telephone at the Project site.
   7. At least one person thoroughly trained in first aid procedures shall be present on the site, whenever Work is in progress. These persons must have a certificate indicating that they have completed a first aid training course conducted by the American Red Cross or other approved agency. Submit the certificates to the ENGINEER.

C. Provide facilities and fixtures in compliance with all applicable federal, state, and local laws, ordinances, standards, and regulations.

D. Maintain strict supervision of use of facilities.

E. Maintain, service and clean facilities and keep them supplied continuously with soap, towels, paper and all other required supplies.

F. Enforce proper use of sanitary facilities, including preventing the committing of nuisances in buildings on the site.

G. Dispose of all wastes in conformance with applicable regulations.

1.2 COSTS OF INSTALLATION AND OPERATION

A. Pay all cost including installation, maintenance and removal.

1.3 USE OF EXISTING SYSTEM (NOT USED)

A. Existing facilities may not be used, unless an agreement is obtained in writing from the OWNER stating the conditions of use.

1.4 USE OF PERMANENT FACILITIES

A. Permanent facilities shall not be used by construction personnel.

1.5 INSTALLATION AND REMOVAL

A. Temporary flush toilets or portable toilets may be used.

B. Comply with all applicable provisions of Mechanical Divisions.

C. Completely remove temporary materials and equipment upon completion of construction and restore all damaged facilities to original condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials or products which can contact drinking water shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with Arizona Administrative Code R18-04-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 55 00

VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all temporary construction roads, walks and parking areas required during the construction and for use of emergency vehicles. Temporary roads and parking areas shall be designed and maintained by CONTRACTOR so as to be fully usable in all weather conditions.

B. Prevent interference with traffic and the OWNER'S operations on existing roads. Indemnify and save harmless the OWNER from any expenses caused by CONTRACTOR'S operations over these roads.

C. Roadway damage shall be restored to the original condition by CONTRACTOR subject to approval of the OWNER or ENGINEER.

D. Temporary roads, walks and parking areas shall be removed by CONTRACTOR, prior to Final Acceptance, and the ground returned to its original condition, unless otherwise required by the Contract Documents.

1.2 DESIGNATED PARKING

A. All CONTRACTOR'S employee vehicles shall park in an area specifically designated for that purpose, as more fully described in Section 01 57 33, Temporary Security.

1.3 MAINTENANCE OF ROADS

A. At all times maintain approved access for trucks to loading areas of the plant and parking facilities for plant personnel. All parking of construction vehicles shall be in approved lots.

B. Have all paved roads swept by mechanical sweeper, a minimum of 2 times a week or as directed by the ENGINEER. Keep roads serviceable at all times. Specific roads include:
   1. All roads within the limits of this Contract.
   2. Surface roads from entrance to work parking, work sites, and adjacent businesses.

C. Dust resulting from construction shall be controlled by CONTRACTOR to prevent a nuisance on the site or in adjacent areas. Apply water or use other methods subject to the ENGINEER'S approval, which will keep dust in the air to a minimum. Use of water will not be permitted when it results in hazardous or objectionable conditions such as ice, mud, ponds and pollution, refer to Section 01 41 27, Earthmoving and Dust Control.

D. Provide temporary heavy duty steel roadway plates to protect existing manholes, handholes, valve boxes and vaults.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 55 26

MAINTENANCE AND PROTECTION OF TRAFFIC

PART 1 - GENERAL

1.1 DESCRIPTION

A. All streets and trafficways shall be kept open for the passage of traffic and pedestrians during the construction period, unless otherwise approved by the ENGINEER, in writing, or authority having jurisdiction over same. Construction traffic at the Lift Station 40 site shall only use the entrances stated in Section 01 57 33, Temporary Security.

B. When required to cross, obstruct or temporarily close a street or trafficway, provide and maintain suitable bridges, detours or other approved temporary expedient for the accommodation of traffic. Closings shall be for the shortest time practical, and passage shall be restored immediately after completion of backfill and temporary paving or bridging.

C. Give the required advance notice to the fire and police departments of proposed operations.

D. Give reasonable notice to owners or tenants of private property who may be affected by CONTRACTOR'S operations. A minimum 7 day notice shall be given.

E. Provide signs, signals, barricades, flares, lights and all other equipment, service and personnel required to regulate and protect all traffic and warn of hazards. All such work shall conform to requirements of the OWNER or authority having jurisdiction. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified conditions.

1.2 TRAFFIC SIGNALS AND SIGNS

A. Provide and operate traffic control and directional signals required to direct and maintain an orderly flow of traffic in all areas under CONTRACTOR'S control, or affected by CONTRACTOR'S operations.

B. Provide traffic control and directional signs, mounted on barricades or standard posts at the following locations:
   1. Each change of direction of a roadway and at each crossroad.
   2. Detours and hazardous areas.
   3. Parking areas.

1.3 FLAGMEN

A. Provide qualified and suitably equipped flagmen when construction operations encroach on traffic lanes, as required for regulation of traffic and in accordance with the requirements of the authority having jurisdiction.

1.4 FLARES AND LIGHTS

A. Provide flares and lights during periods of low visibility:
   1. To clearly delineate traffic lanes, to guide traffic and to warn of hazardous areas.
   2. For use by flagmen in directing traffic.

B. Provide illumination of critical traffic and parking areas.

1.5 PARKING CONTROL

A. Control all CONTRACTOR related vehicular parking within the limits of the Work to preclude interference with public traffic or parking, access by emergency vehicles, OWNER'S operations, or construction operations. Provide temporary parking facilities for the public, as may be required because of construction or operations.

B. Monitor parking of all construction and private vehicles:
   1. Maintain free vehicular access to and through parking areas.
   2. Prohibit parking on or adjacent to access roads or in non-designated areas.
   3. All construction vehicles must possess current registration.
   4. Private vehicles shall park only in the designated areas.

1.6 HAUL ROUTES

A. Consult with governing authorities and establish thoroughfares which will be used as haul routes and site access.

B. Drawings indicate haul routes which have been designated by authorities to be used for construction traffic.

C. Submit requested routes to ENGINEER and OWNER for designation as haul route and secure approval of authorities.

D. Confine construction traffic to designated haul routes.

E. Provide traffic control at critical areas of haul routes to expedite traffic flow, and to minimize interference with normal public traffic.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION +

SECTION 01 57 00

TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and maintain methods, equipment, and temporary construction, as necessary to provide controls over environmental conditions at the construction site and adjacent areas. Remove physical evidence of temporary facilities at completion of Work.

B. Obtain all City, County and State permits required for the construction of all Work, including Hazardous Material Management, Earth Moving/ Dust Control and Stormwater/Stormwater Pollution Prevention Permits.

1.2 NOISE CONTROL

A. CONTRACTOR'S vehicles and equipment shall be such as to minimize noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and in no case will noise levels be permitted which interfere with the Work of the OWNER or others.

1.3 PEST AND RODENT CONTROL

A. Provide rodent and pest control as necessary to prevent infestation of construction or storage areas.
   1. Employ methods and use materials that will not adversely affect conditions at the site or on adjoining properties.

1.4 WATER CONTROL

A. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties.
   1. Control fill, grading and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses so as to prevent any erosion, damage or nuisance.

1.5 EROSION CONTROL

A. Plan and execute construction and earth work by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   1. Hold the areas of bare soil exposed at one time to a minimum.
   2. Provide temporary control measures such as berms, dikes and drains.

B. Construct fills and waste areas by selective placement to eliminate surface silts or clays which will erode.

C. Periodically inspect earthwork to detect any evidence of the start of erosion; apply corrective measures as required to control erosion.

D. Coordinate erosion control requirements with the requirements of Article 1.4, above.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 57 23

STORMWATER POLLUTION PREVENTION PLAN AND PERMIT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Comply with the terms and conditions of the Arizona Pollutant Discharge Elimination System (AZPDES) requirements under the Arizona Department of Environmental Quality (ADEQ) General Permit. Under provisions of that permit, CONTRACTOR is designated as permittee and responsible for providing necessary material and for taking appropriate measures to minimize pollutants in stormwater runoff from the Project. Obtain a DeMinimus discharge permit from ADEQ for any discharge that is to Waters of the U.S., and comply with the requirements of the permit.

B. The Contract Price shall include all material, labor and other permits and incidental costs related to:
   1. Preparing, updating and revising the Stormwater Construction Pollution Prevention Plan (SWPPP).
   2. Installing and maintaining all structural and non-structural items chosen by CONTRACTOR to comply with the construction SWPPP.
   3. Clean-up and disposal costs associated with clean-up and repair following storm events or CONTRACTOR caused spills on the Project.
   4. Implementing and maintaining Best Management Practices to comply with the OWNER'S stormwater code.
   5. Preparing the Notice of Intent and Notice of Termination shall be covered by the AZPDES General Permit for Arizona.
   6. Obtain and comply with DeMinimus permit, if such permit is required.

C. Coordinate the requirements under this Section with Section 31 23 00, Structural Excavation and Backfill, permit requirements. All necessary SWPPP controls and practices must be implemented prior to commencement of any construction activity.

1.2 SUBMITTALS

A. Submit, at least two days prior to the initial start of construction on the project; completed and signed Notice of Intent forms to the State of Arizona at the following addresses:
   1. Stormwater Program – Water Permits Section / NOI
      Arizona Department of Environmental Quality
      1110 West Washington, 5415B-3
      Phoenix, AZ 85007

B. Submit to the OWNER, no later than 14 days before submitting to the State agency the following:
   1. Notice of Intent (NOI) to be covered by the AZPDES General Permit for Arizona, including certifications of signature.

2. SWPPP for the Project, including certification of signature. Stormwater Plan shall include CONTRACTOR'S proposed temporary means for stormwater control during all phases of construction and include stormwater pumping/retention plans. This submittal shall be coordinated with CONTRACTOR'S Excavation Plan submittal, specified in Section 31 23 00, Structural Excavation and Backfill.
3. A manual has been prepared by the Maricopa County Flood Control District to aid in CONTRACTOR'S preparation of the SWPPP. This manual, "Drainage Design Manual for Maricopa County Arizona, Volume III, Erosion Control" is available at the Flood Control District Office, 2801 West Durango Street, Phoenix, Arizona. The complete Construction General Permit is in the December 8, 1999, Federal Register available at local libraries and is also available from the ADEQ website at www.adeq.state.az.us/environ/water/permits/download/constgp.pdf.

C. Submit to the OWNER, as part of the Construction SWPPP a construction site inspection report that includes the following:
   1. Inspection scope.
   2. Inspector qualifications.
   3. Observations of SWPPP non-compliance and corrective steps taken.
   4. Certificate of Compliance with SWPPP and the AZPDES General Permit for Stormwater Discharge in the event of no incidents. Reports shall be submitted each quarter, at a minimum, throughout the Contract duration.

D. Submit to the OWNER, upon project completion the Notice of Termination (NOT) of coverage under AZPDES General Permit.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 57 33

TEMPORARY SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Safely guard all Work, materials, equipment and property from loss, theft, damage and vandalism. CONTRACTOR'S duty to safely guard property shall include the OWNER'S property and other private property from injury or loss in connection with the performance of the Work.

B. Employ watchmen as required to provide the required security and prevent unauthorized entry.

C. Make no claim against the OWNER for damage or injury resulting from trespass.

D. Responsible for security and shall make good all damage to property of OWNER and others arising from failure to provide adequate security. The standard for security shall be, at a minimum, equivalent to the owner's standards.

E. If the existing fencing or barriers are breached or removed for purposes of construction, provide and maintain temporary security fencing equal to the existing in a manner satisfactory to the ENGINEER and OWNER. Provide additional security staff, if required, to maintain the security of the facility.

F. Security measures taken shall be at least equal to those usually provided by OWNER to protect his existing facilities during normal operation.

G. Maintain security program throughout the Work until OWNER'S acceptance and occupancy precludes need for CONTRACTOR'S security program.

H. Comply with all aspects of OWNER'S site specific Security Guard Protocol. This shall include background checks equivalent to those conducted by the owner.

I. All costs for security as specified in this Section shall be borne by CONTRACTOR.

1.2 CONTRACTOR'S ACCESS TO THE SITE

A. Access to the Lift Station 40 site for CONTRACTOR'S employees, material, tools and equipment shall be from the designated construction entrance.

B. Ensure that each of his employees, representatives, delivery persons, suppliers and others acting for CONTRACTOR, shall be subject to the following regulations:
   1. CONTRACTOR'S subcontractor's, suppliers and manufacturer's employee's shall not park anywhere other than CONTRACTOR Employee's Parking Area. The Area shall be designated by the ENGINEER. Prepare and maintain this area, as required.
   2. All CONTRACTOR employees shall wear a laminated photograph identification and badge bearing CONTRACTOR'S name, employee's name, and employee number at all times when the employee is on the site. Badge and Background Check Data form shall be completed by CONTRACTOR and approved by OWNER prior to CONTRACTOR personnel entering the site.
   3. Turn over the identification badge to the OWNER upon the individual's completion of the participation on the project or project completion.
   4. OWNER reserves all rights to the approval of all CONTRACTOR, subcontractor, suppliers and manufacturers employees receiving an identification badge.
   5. All vehicles, including those belonging to CONTRACTOR, his employees and subcontractors, delivery persons and suppliers entering the plant site shall conform to all security and safety regulations in force at the site. All vehicles entering and leaving the facility are subject to search.
   6. Personal vehicles shall not be allowed outside CONTRACTOR'S Employee Parking Area.
   7. Delivery vehicles shall access the site from the designated construction entrance road.
   8. Access to the Lift Station site from any other entrance is strictly prohibited, unless prior approval is obtained from the OWNER. Violators shall be banned from the site.
   9. Firearms are not allowed on City property.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 58 00

PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish, install and maintain temporary project identification and informational signs.

B. The following signs shall be provided:
   1. Project Information Sign.
   2. Dust Control Complaint Sign.
   3. Other signs as directed by OWNER and/or ENGINEER.

C. No signs, except those specified, shall be displayed, unless approved by OWNER.

1.2 SUBMITTALS

A. Submit for approval the following:
   1. Type of grade of materials.
   2. Layout, size, trim, framing, supports and coatings.
   3. Size and style of lettering.
   4. Samples of colors.

1.3 CONSTRUCTION

A. Use 3/4-inch exterior grade plywood, unless shown otherwise.

B. Use, trim, mitered on all edges.

C. Design signs and supports to withstand 75 mile per hour wind.

D. Paint with exterior gloss-finish enamel. Sign painter shall be a professional in the type work required.

1.4 INSTALLATION AND MAINTENANCE

A. Location of signs shall be as shown or directed by ENGINEER.

B. Maintain signs so they are clean, legible and upright. Keep grass and weeds cut away from signs.

C. Repair and repaint damaged signs. Relocate signs as required by progress of the Work.

D. Remove signs when project is completed or when directed by ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 65 00

PRODUCT DELIVERY REQUIREMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work.

B. Shipments of materials to CONTRACTOR or subcontractors shall be delivered to the site only during regular working hours and shall conform to the requirements of Section 01 66 13, CONTRACTOR'S Hazardous Materials Management Program. Shipments shall be addressed and consigned to the proper party giving name of Project, street number and city. Shipments shall not be delivered to OWNER, except where otherwise directed.

C. If necessary to move stored materials and equipment during construction, move materials and equipment without any additional compensation.

1.2 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or label outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, OWNER'S contract name and number, CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Protect products from exposure to the elements and keep thoroughly dry and dust free at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

D. Advance Notice to ENGINEER of Shipments: Upon receipt of manufacturer's advance notice of shipment, provide ENGINEER seven-day advance notice of anticipated date and place of arrival of the following:
   1. Submersible Pumps
   2. Ferrous Chloride System Pumps
   3. Pumps
   4. VFDs.
   5. Generators.
   6. Transformers.

E. Do not have products shipped until:
   1. Related Shop Drawings have been approved by ENGINEER.
   2. Related factory test results, required in the individual Specification Sections,

have been reviewed and accepted by ENGINEER.
3. Required storage facilities have been provided.

F. Items shall be supported, packaged and stored in such a way so as not to impose undue stress/forces to couplings, connections, supports, valves, equipment and instruments.

1.3 DELIVERY

A. Arrange, with the United States Postal Service, a special address for the Project. All deliveries shall be made to that address.

B. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation.

C. Coordinate deliveries to avoid conflict with Work and conditions on site and to accommodate the following:
1. Work of other contractors, or OWNER.
2. Limitations of storage space.
3. Availability of equipment and personnel for handling products.
4. OWNER'S use of premises.

D. Do not have products delivered to Project site until related Shop Drawings have been approved by the ENGINEER.

E. Do not have products delivered to Project site until required storage facilities have been provided.

F. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep ENGINEER informed of delivery of all equipment to be incorporated in the Work.

G. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.

H. Immediately on delivery, inspect shipment to assure:
1. Product complies with requirements of Contract Documents and reviewed submittal.
2. Quantities are correct.
3. Containers and packages are intact, and labels are legible.
4. Products are properly protected and undamaged.
5. Verify that the accelerometer recordings were made during shipment.

I. Promptly remove damaged products from the Project site and expedite delivery of new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.4 PRODUCT HANDLING

A. Provide equipment and personnel necessary to handle products, including those provided by OWNER, by methods to prevent soiling or damage to products or packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.

C. Handle products by methods to prevent bending or overstressing.

D. Lift heavy components only at designated lifting points.

E. Materials and equipment shall at all times be handled in a safe manner and as recommended by manufacturer or supplier so that no damage will occur to them. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Store and protect materials in accordance with manufacturer's recommendations and requirements of Specifications.

B. Make all arrangements and provisions necessary for the storage of materials and equipment. All excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities and so that free access can be maintained at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants and occupants. Arrange storage in a manner to provide easy access for inspection. Storage shall be contained at the Lift Station 40 site or CONTRACTOR's offsite storage location.

C. Areas available on the site for storage of materials and equipment shall be as shown or approved by the ENGINEER.

D. Materials and equipment, which are to become the property of the OWNER, shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the Work, including proper protection against damage by freezing, moisture and summer temperatures with ambient temperatures as high as 120°F. They shall be placed in inside climate storage areas, unless otherwise acceptable to OWNER. When placing orders to suppliers for equipment and controls containing computer chips, electronics and solid-state devices, request and coordinate specific temperature limitations on equipment since cabinets and components stored in the summer can approach temperatures of 200°F.

E. Be fully responsible for loss or damage, including theft, to stored materials and equipment.

F. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified.

G. Do not store products in the structures being constructed, unless approved in writing by the ENGINEER.

H. Lawns, grass plots or other private property shall not be used for storage purposes without written permission of the OWNER or other person in possession or control of such premises.

1.2 PROTECTION

A. Equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage. Each container or piece of equipment shall be clearly marked with CONTRACTOR'S name, project name and location. Equipment shall be stored on raised supports protected from exposure to the elements and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, instrumentation equipment (controls, devices, panels, etc.) and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities, such as warehouses. Covering with visquine or similar material shall not be considered as a weathertight enclosure.

B. Painted surfaces shall be protected against impact, abrasion, discoloration and other damage. Painted equipment surfaces, which are damaged prior to acceptance, shall be repainted in entirety to the satisfaction of the ENGINEER.

C. Electrical equipment, controls, and instrumentation shall be protected against moisture, water damage, heat or dust. Space heaters provided in the equipment shall be connected and operating at all times until equipment is placed in operation.

D. Items shall be stored in such a way so as not to impose undue stress/forces to couplings, connections, supports, valves, equipment and instruments.

1.3 UNCOVERED STORAGE

A. The following types of materials may be stored outdoors without cover:
   1. Masonry units.
   2. Reinforcing steel.
   3. Structural steel.
   4. Piping, except PVC.
   5. Precast concrete items.
   6. Castings.

B. Store the above materials on wood blocking so there is no contact with the ground.

1.4 COVERED STORAGE

A. The following types of materials may be stored outdoors if covered with material impervious to water:
   1. Rough lumber.
   2. Handrailing.
   3. PVC Piping.
   4. Filter Media.

B. Tie down covers with rope and slope to prevent accumulation of water on covers.

C. Store materials on wood blocking or skids.

D. Store loose granular materials, covered with materials impervious to water, in a well-drained area or solid surfaces to prevent mixing with foreign matter.

1.5 FULLY PROTECTED STORAGE

A. Store all products not named above in buildings or trailers which have a concrete or wooden floor, a roof, and fully closed walls on all sides.

B. Provide heated storage space for materials which could be damaged by freezing.

C. Provide air-conditioned storage space for materials that could be damaged by Arizona's severe high temperatures.

D. Protect mechanical and electrical equipment from being contaminated by dust, dirt and moisture.

E. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.6 HAZARDOUS PRODUCTS

A. Prevent contamination of personnel, the storage area and the site. Comply with the requirements of the Specification Section 01 66 13, CONTRACTOR'S Hazardous Materials Management Program, codes and manufacturer's instructions.

1.7 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on a scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on a continuing basis.
   3. Products exposed to elements are not adversely affected.

B. Mechanical and electrical equipment which require long term storage shall have complete manufacturer's instructions for servicing each item with notice of enclosed instructions shown on exterior of package.
   1. Comply with manufacturer's instructions on a scheduled basis.
   2. Space heaters which are part of electrical equipment shall be connected and operated continuously until equipment is placed in service.

1.8 PANEL AND INSTRUMENTATION STORAGE

A. All panels, microprocessor-based equipment and all other devices subject to damage or useful life decrease, because of temperatures below 40°F or above 100°F, relative humidity above 90 percent, or exposure to rain or exposure to blowing dust shall not be stored on site.

B. Storage shall be in an insured, climate-controlled warehouse within Maricopa County. The OWNER shall have the right to inspect the equipment during normal working hours. Placed inside each panel or device shall be a desiccant, volatile corrosion inhibitor blocks (VCI), a moisture indicator and maximum-minimum indicating thermometer. The panels and equipment shall be checked once per month. The desiccant, VCI and moisture indicator shall be replaced as often as required or every six months, whichever occurs first. A certified record of the daily

maximum and minimum temperature and humidity in the warehouse shall be available for inspection by the OWNER. A certified record of the monthly inspection, noting maximum and minimum temperature for the month, condition of desiccant, VIC and moisture indicator, shall also be available for inspection by the OWNER.

C. All costs for the storage shall be at no additional cost to the OWNER. Any panel or device which has been damaged by any cause or for which the storage temperatures or humidity range has been exceeded shall be replaced at no additional cost to the OWNER and shall not be cause for a delay in Contract completion.

D. The panels and equipment shall not be shipped to the site until field conditions are ready for installation, including all slabs, walls, roofs, and environmental controls. The failure to have the site ready for installation shall not relieve CONTRACTOR from conforming to all of the Contract requirements.

1.9 RECORDS

A. Keep running account of products in storage to facilitate preparation of progress payments, if Agreement provides for payment for products delivered, but not installed in the Work.

B. A record shall be kept of the storage requirements and a continuous maintenance log for all stored equipment. A tag shall be applied to each piece of equipment showing all service dates and who did the service.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 66 13

CONTRACTOR'S HAZARDOUS MATERIALS MANAGEMENT PROGRAM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Comply with all Federal, State, and local Laws and Regulations related to environmental protection and environmental safety including, but not limited, to the following:
   1. Title 29 Code of Federal Regulations Parts 1910, Occupational Safety and Health.
   2. Title 40 Code of Federal Regulations, Environmental Protections.
   3. Title 49 Code of Federal Regulations, Transportation.
   4. State Occupational Safety and Health Administration (OSHA).
   5. Arizona Department of Environmental Quality (ADEQ).
   6. Arizona Department of Water Resources (ADWR).
   7. Maricopa County Air Pollution Control Regulations.

B. In order to ensure the OWNER that CONTRACTOR is complying with the intent of the regulations stated in Paragraph 1.1.A, above, as they relate to the on site use of hazardous materials, hazardous wastes and other substances similarly defined in those regulations, develop and maintain a CONTRACTOR'S Hazardous Materials Management Program that includes as a minimum, but is not limited to the requirements specified herein. The interests of the OWNER are that accidental spills, site contamination, and injury of personnel on the site are avoided. OWNER will not enforce suspected violations of the rules and regulations referenced in Paragraph 1.1.A, above, however the OWNER will notify CONTRACTOR of suspected violations. If in the opinion of the OWNER, CONTRACTOR fails to address the suspected violations in a timely and appropriate manner, OWNER will notify Federal, State, or local regulatory agencies, report the suspected violations to them, and request that they inspect CONTRACTOR'S operations. Any fines that may be levied against OWNER for violations committed on the site by CONTRACTOR, as well as any costs to OWNER associated with cleanup of materials, shall be reimbursed immediately by CONTRACTOR. All documents required by the program shall be made available to the OWNER'S Environmental Representative immediately, upon request.

C. Responsibility for any hazardous waste, as defined in any of the above listed regulations, and those generated by the CONTRACTOR, belongs to CONTRACTOR. If CONTRACTOR is going to generate, or has generated, a substance that qualifies as a hazardous waste, must obtain an EPA identification number, listing CONTRACTOR'S name and construction site address as the generator of the hazardous waste. Responsibility for the identification, analysis, profiling, transport and disposal of hazardous wastes generated, belongs to CONTRACTOR. The identification number can be obtained from the Arizona Department of Environmental Quality (ADEQ). This number shall be provided to the ENGINEER within 30 days after the Notice to Proceed, or before any hazardous materials are brought onto the site.

1.2 HAZARDOUS MATERIALS PROGRAM REQUIREMENTS

A. Within the regulations listed in Paragraph 1.1.A, above, terms such as hazardous material, hazardous wastes, and similar terms have varying definitions. To dispel confusion regarding what materials fall under the Program Requirements and for the purposes of this Article, Hazardous Material is defined as “any material, whether solid, semi-solid, liquid, or gas, which, if not stored or used properly, may cause harm or injury to persons through inhalation, ingestion, absorption or injection, or which may negatively impact the environment through the use or discharge of the material on the ground, in the water (including groundwater), or to the air.”

B. All chemicals brought onto the site must be approved by OWNER. Prior to bringing any chemical on site, request approval from OWNER’S Environmental Representative for each chemical CONTRACTOR proposes to bring on site. At the time of request, OWNER’S Environmental Representative may request and receive from CONTRACTOR, specific information associated with each chemical. The specific information may include, but is not limited to, MSDS, manufacture, vendor, container size(s), number of containers, minimum and maximum volume of material intended to be stored on site, as well a description to the process or procedures in which any requested chemical is to be used. OWNER, within 5 working days from receipt of the specific chemical information, will inform CONTRACTOR as to whether the chemical has been approved for use on site.

C. Maintain on site two notebooks containing (1) a chemical inventory, and (2*)* current (dated within the past two years) Material Safety Data Sheets for all materials being used on site, whether or not they are defined as a Hazardous Material in Paragraph 1.2.A, above. One notebook shall be kept in CONTRACTOR’S on-site office and the other shall be kept in a location specified by the OWNER’S Environmental Representative. These notebooks must be kept up-to-date as materials are brought onto and removed from the site. Copies of MSDS sheets for chemicals removed from the site shall be provided to the OWNER’S Environmental Representative.

D. Develop an emergency/spill response plan, for each hazardous material or class/group of materials. As a minimum, the response plan must address the following:
   1. Provide a description of equipment on site available to contain or respond to an emergency/spill of the material.
   2. Notification procedures.
   3. Response coordination procedures between CONTRACTOR, OWNER, and ENGINEER.
   4. Provide a Site Plan showing the location of stored hazardous materials and location of spill containment/response equipment.
   5. Provide a description of the hazardous material handling and spill response training provided to CONTRACTOR’S employees.

E. In accordance with applicable Laws and Regulations, properly and safely store all hazardous materials, which shall include as a minimum, the following:
   1. Have a designated storage site for hazardous materials that includes secondary containment. The site must include barriers to prevent vehicles from colliding with the storage containers and offer protection from environmental factors such as weather.

2. Provide signage in accordance with applicable Laws and Regulations, clearly identifying the hazardous materials storage site.
3. All hazardous materials containers must bear the applicable Hazard Diamonds.

F. Properly label all containers of consumable materials, whether or not they are classified as Hazardous Materials under this Section. The name of CONTRACTOR or subcontractor shall be stenciled on any container containing a hazardous material and on any container over five-gallon capacity containing a non-hazardous material. Any container must have a label clearly identifying the contents. If any such unlabeled containers are discovered on the site, the OWNER'S Environmental Representative will notify CONTRACTOR. Responsibility to remove such containers belongs to CONTRACTOR. Containers will be properly labeled or removed it from the site within one hour. Any containers that are filled from larger containers must also be properly labeled.

G. OWNER encourages storage of hazardous materials off site until the materials are needed on site.

H. Provide all documentation required herein available immediately upon request of OWNER'S Environmental Representative. CONTRACTOR'S Safety Representative will meet at least monthly with OWNER'S Environmental Representative to review CONTRACTOR'S Hazardous Materials Management Program documents, procedures, and inspect the storage site and job site to ensure the requirements specified herein are being complied with. Also, provide OWNER'S Environmental Representative and the ENGINEER with copies of all permits obtained from environmental regulatory agencies.

I. Provide documentation to ENGINEER and OWNER's Environmental Representative that CONTRACTOR, subcontractors, or others hired by CONTRACTOR making deliveries of hazardous Materials (as defined in Title 49 CFR) to the site are in compliance with Title 49 CFR 172.800 – 172.804, which requires each person who offers for transportation in commerce or transports in commerce one or more of the following hazardous materials, as defined by Title 49 CFR, must develop and adhere to a security plan for hazardous materials that conforms to the requirements of this subpart.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01 71 23

FIELD ENGINEERING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR will establish a base line for the Project and two benchmarks for use by the ENGINEER and CONTRACTOR during the project. The ENGINEER and CONTRACTOR will coordinate the location of the benchmarks and base line to suit the Work.

B. CONTRACTOR:
   1. Provide civil, structural and other professional engineering services specified, or required to execute CONTRACTOR'S construction methods.
   2. Develop and make all detail surveys and measurements needed for construction including slope stakes, batter boards, and all other working lines, elevations and cut sheets.
   3. Provide all material required for bench marks, control points, batter boards, grade stakes, structure and pipeline elevation stakes, and other items.
   4. Be solely responsible for all locations, dimensions and levels. No data other than written orders of the ENGINEER shall justify departure from the dimensions and levels required by the Contract Documents.
   5. Safeguard all points, stakes, grade marks, monuments and bench marks made or established on the Work. Re-establish same with the exception of primary control monuments if disturbed and rectify all Work improperly installed because of not maintaining, not protecting or removing without authorization established points, stakes, marks and monuments.
   6. Provide such facilities and assistance as may be necessary for ENGINEER to check line and grade points placed by CONTRACTOR. Do not perform any excavation or embankment work until all cross-sectioning necessary for determining pay quantities has been completed and checked by ENGINEER.
   7. CONTRACTOR shall provide notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the Work. If CONTRACTOR observes that the Contract Documents are at variance therewith, promptly notify the ENGINEER, in writing.

1.2 CONTRACTOR'S FIELD ENGINEER

A. Employ and retain at the site of the Work a field engineer with the experience and capability of performing all engineering tasks required of CONTRACTOR. Tasks included are:
   1. CONTRACTOR shall provide daily reports that shall consist of the following items as specified herein.
      a. Number of employees along with start and end of shift times.
      b. Subcontractor employees.
      c. Breakdown of employees by trades.
      d. Major equipment and materials installed.
      e. Major construction equipment utilized.

f. Location of all areas in which construction was done.
g. Materials and equipment received.
h. Work and tests performed.
i. Weather conditions.
j. Safety.
k. Delays.
l. Instructions received.

2. CONTRACTOR shall submit electronic PDF of CONTRACTOR'S daily reports. The daily report is due at the ENGINEER'S field office by 9:00 a.m. the next working day after the Work was performed and shall be signed by a responsible member of CONTRACTOR'S staff. ENGINEER and CONTRACTOR shall review and agree to information provided, upon acceptance ENGINEER shall sign the completed and agreed upon form.
3. CONTRACTOR shall check all formwork, reinforcing, inserts, structural steel, bolts, sleeves, piping, other materials and equipment.
4. CONTRACTOR shall maintain field office files and drawings, Record Drawings, and coordinate engineering services with subcontractors. Prepare layout and coordination drawings for construction operations.
5. CONTRACTOR shall check and coordinate Work for conflicts and interferences and immediately advise ENGINEER of all discrepancies noted.
6. CONTRACTOR shall cooperate with ENGINEER in field inspections, as required.
7. CONTRACTOR shall review and coordinate Shop Drawings and other submittals.

1.3 CONTRACTOR'S SURVEYOR

A. CONTRACTOR shall employ and retain, as needed and requested by the ENGINEER, at the Work site a surveyor with the experience and capability of performing all surveyor and layout tasks required of CONTRACTOR. The surveyor shall be a land surveyor registered in the State of Arizona. Tasks included are:
   1. CONTRACTOR shall provide all surveying equipment required including transit, level, stakes and required surveying accessories.
   2. CONTRACTOR shall furnish all required lines and grades for construction of all facilities, structures, pipelines and site improvements.
   3. CONTRACTOR shall keep professional, accurate, well organized, and legible notes of all measurements and calculations made while surveying and laying out the Work.
   4. Survey, locate, and record and redline Drawings to accurately represent all utilities and buried structures prior to backfilling.

B. Any primary control survey monuments damaged or destroyed, will be re-established by the ENGINEER, at CONTRACTOR'S expense.

C. CONTRACTOR shall perform such surveys and computations as are necessary to determine quantities of Work performed or placed during each progress payment period, and shall perform all surveys necessary for the ENGINEER to determine final quantities of Work in place.

D. CONTRACTOR shall notify the ENGINEER at least 24 hours before performing a quantity survey and, unless waived in writing by the ENGINEER, quantity surveys shall be performed in the presence of the ENGINEER.

E. From established primary control points, establish all lines and grades, and elevations necessary to control the Work, and shall be responsible for all measurements that may be required for execution of the Work to the tolerances prescribed in the Contract Documents.

F. Establish, place, and replace as required, such additional stakes, markers, and other controls as may be necessary for control, intermediate checks, and guidance of construction operations.

1.4 SURVEYING

A. CONTRACTOR shall follow the following construction surveying guidelines for this project:
   1. Alignment Staking: Each 50 feet on tangent; each 25 feet on curves.
   2. Slope Staking: Each 50 feet on tangent; each 25 feet on curves; restake every 10 feet in elevation.
   3. Structure: Stake out structures, including elevations; checkouts prior to and during construction.
   4. Pipeline: Stake out pipelines including elevations; checkout prior to and during construction.
   5. Road: Tops each 50 feet on tangent and each 25 feet on curves.
   6. Cross-Section: Original, final and intermediate as required, for the structure sites and other locations as necessary for quantity surveys.
   7. Easement Staking: Each 50 feet on tangent; each 25 feet on curves. Also wooden laths with flagging at 100 feet maximum spacing.
   8. Record Staking: Provide permanent stake where blind flanges or caps are provided for future connecting, with a material acceptable to the ENGINEER.

B. Temporary survey references set by CONTRACTOR for CONTRACTOR'S own use shall be established to at least second order accuracy (e.g., 1:10000). Construction staking used as a guide for the actual Work shall be set at least third order accuracy (e.g., 1:5000). The basis on which such orders are established shall be sufficient to provide the absolute margin for error specified below.

C. The horizontal accuracy of easement staking shall be plus or minus 0.1 feet. The accuracy of all other staking shall be plus or minus 0.04 feet horizontally and plus or minus 0.02 feet vertically.

D. Survey calculations shall include an error analysis sufficient to demonstrate the required accuracy.

E. Survey Records:
   1. Maintain a complete, accurate log of all control and survey Work as it progresses.
   2. All survey data shall be in accordance with recognized professional surveying standards. All original field notes, computations, and other surveying data

shall be recorded by CONTRACTOR'S surveyor in CONTRACTOR furnished hard-bound field books, and shall be signed and sealed by CONTRACTOR'S surveyor. The completeness and accuracy of all survey Work, and the completeness and accuracy of the survey records, including the field books, shall be the responsibility of CONTRACTOR. Failure to organize and maintain survey records in a professional manner to allow reasonable and independent verification of all calculations by the ENGINEER, and to allow reasonable identification by the ENGINEER of all elevations, dimensions, and grades of the Work shall be cause for rejection of the survey records, including the field books.

3. Illegible notes or data, or erasures on any page of the field books is not acceptable. Copied notes or data shall not be permitted. Corrections by ruling or lining out errors will be satisfactory only if initialed by the surveyor. Violation of the above may require resurveying the data in question.

F. Survey Submittal:
   1. Survey submittal shall be made as described herein. Submittal shall be signed and sealed by CONTRACTOR'S surveyor and shall include:
      a. A complete survey plan that shall be submitted ten days prior to beginning survey Work.
      b. Resumes shall be submitted of the Registered Land Surveyors conducting the Work ten days prior to beginning survey Work. During the course of the Work, a resume shall be submitted for each new Registered Land Surveyor working on the project at least ten days prior to the beginning of Work by such new Registered Land Surveyor.
      c. A sample of the proposed survey field books to be maintained by CONTRACTOR'S surveyor. The sample shall have sufficient information and detail, including example calculations and notes, to demonstrate that the field books will be organized and maintained in a professional manner, meeting the requirements of Article 1.3 and Article 1.4 of this Section.
      d. The original field books shall be submitted within two days upon completion of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION) + +

SECTION 01 73 19

INSTALLATION OF EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes Work necessary to install equipment and materials to be incorporated into this Project. It supplements the Specification requirements in Division 2, Existing Condition, through Division 48, Electrical Power Generation.

B. Shop Drawings, installation drawings and instructions furnished by the manufacturers shall be used by CONTRACTOR in the installation of the equipment and materials.

1.2 ANCHOR BOLTS AND GROUT

A. Anchors and adhesive anchors shall be furnished by CONTRACTOR, as specified and required. Use adhesive anchors only where shown or approved by ENGINEER or required by the manufacturer. Anchors and adhesive anchors shall be of specified materials with heavy hexhead nuts. Anchorage items shall conform to the applicable requirements of Section 03 15 19, Anchorage in Concrete.

B. Grouting shall be in accordance with Section 03 60 00, Grouting, and Section 11 00 00, Equipment.

1.3 TRANSPORTING, HANDLING AND INSTALLING EQUIPMENT AND MATERIALS

A. Conform to requirements of Section 11 00 00, General Equipment Provisions, and Section 01 65 00, Product Delivery Requirements.

B. Employ competent mechanics experienced in the installation of the types of equipment and materials to be furnished, and shall ensure that all equipment and materials are installed in accordance with the recommendations of the manufacturers.

1.4 EQUIPMENT ERECTION

A. General: Conform to the following as a minimum:
   1. Use only mechanics, machinists or mill wrights skilled in the handling, setting, aligning, leveling and adjusting of the type of equipment and materials furnished.
   2. Use only an oil bath heater to expand couplings, gears, etc. Do not force or drive them on equipment shafts, nor subject them to an open flame or torch.
   3. Wedging shall not be permitted. Use the least number of flat shims possible in leveling equipment. Shims shall be clean and free of slags. Provide all shims, filling pieces, keys, packing, red or white lead grout, or other materials necessary to properly align, level and secure apparatus in place. When

requested by ENGINEER, demonstrate that all elements so required are level and plumb. Grind as necessary to bring parts to proper bearing after erection.

4. Use proper tools in the assembly of equipment and materials to prevent deforming or marring the surface of shafts, nuts or other parts.
5. Tighten connections requiring gaskets evenly all around to ensure uniform stress over the entire gasket area.
6. Equipment and materials shall not be altered or repaired, and no burning or welding shall be permitted on any parts having machined surfaces, except by written permission of ENGINEER.
7. No rigging shall be done from any structure without the permission of ENGINEER. Responsibility for any damage to the structure resulting from this operation, belongs to CONTRACTOR.
8. Use tools, equipment and materials that shall not damage the structure or equipment.
9. Furnish and install plugs in lubrication holes to prevent entry of foreign material.
10. Electrical work, testing, lubricating and painting shall all comply with requirements of the applicable Section.

B. Setting and Erection:
   1. All units shall be carefully set and aligned on their foundations, by qualified millwrights, after their sole plates have been shimmed to true alignment at the anchor bolts. Anchor bolts shall be set in place and the nuts tightened against the shims. Bedplates or wing feet of the equipment shall be further checked after securing to the foundations and, after confirmation of all alignments, the sole plates shall be finally grouted in place. Be responsible for the correct alignment of equipment with its associated piping. “Pipe springing” shall not be allowed.
   2. Misaligned holes shall be reamed. “Driving” of bolts or keys shall not be permitted.

C. Jacking Screws and Anchor Bolts:
   1. All equipment shall be anchored to supporting members by bolts or other connections to accommodate all operating forces and satisfy the seismic restraint requirements of the Phoenix Building Code for Zone 1 Seismic Area. Anchors shall provide resistance to a lateral force of at least 0.30 times the weight of the equipment, including its contents.
   2. Jacking screws shall be provided in the heavy equipment bases and bedplates, and where required elsewhere, to aid in leveling during installation.
   3. Anchor bolt setting drawings shall be delivered sufficiently early to permit setting the anchor bolts when the structural steel support frame is fabricated by others.
   4. All anchor bolts and anchoring hardware shall be of Type 316 stainless steel. Adhesive anchors shall only be used where permitted by the ENGINEER and shall be Type 316 stainless steel. Alternate methods of anchoring to those shown on the Contract Documents shall meet the requirements of this Section and shall be submitted to the ENGINEER for review.

D. Alignment and Leveling:
   1. Field check all shafts, couplings and sheaves for alignment and adjust to manufacturer’s specifications where necessary.
   2. Couplings shall be aligned while the equipment is free from all external loads.

3. Angular and parallel alignment shall be checked, and the actual alignment shall be recorded and submitted to ENGINEER. Alignment shall be within manufacturer's recommended tolerance.
4. Dial indicators shall be used for the checking of angular and parallel alignment. During rotation of the half couplings in performance of this test, they shall be maintained in the same relative position, and the dial indicator readings shall be taken at the same place on the circumference of the coupling.

E. Threaded Connections:
1. Apply a molybdenum disulfide, anti-seize compound to all threads in mechanical connections such as bolts, studs, cap screws, tubing, etc., unless otherwise specified.

F. Equipment Drive Guards:
1. Unless shown or specified otherwise, provide all equipment driven by open shafts, belts, chains, pulleys, sheaves, or gears with all-metal guards conforming to the requirements of Section 11 00 00, General Equipment Provisions.

1.5 EQUIPMENT INSTALLATION

A. Obtain installation instruction booklets or other recommendations from the equipment manufacturers as to procedures for, sequence of, and tolerances allowed in equipment installation. In particular, the manufacturer's recommendations as to grout spaces required, type of grout to be used, and tolerances for level and alignment, both vertical and horizontal, shall be obtained and followed. One copy of this material shall be given to the ENGINEER prior to the installation of the equipment.

B. Whenever applicable, obtain the services of a manufacturer's representative specifically trained in erection of his equipment to supervise the installation. Be responsible for the proper alignment of all installed driven equipment and drives in accordance with the tolerance recommendation of the manufacturers for both OWNER furnished and CONTRACTOR furnished equipment. Within 14 calendar days after installation, submit to the ENGINEER a letter from the manufacturer, on the manufacturer's letterhead, stating all equipment and components are installed in accordance with the manufacturer's requirements and installation instructions as described in these Specifications.

C. Skilled craftsmen experienced in installation of the equipment or similar equipment shall be used. Applicable specialized tools and equipment, such as precision machinist levels, dial indicators, and gauges shall be utilized as required in the installations. The Work shall be accomplished in a workmanlike manner to produce satisfactory equipment installation free of vibration or other defects.

D. Install all OWNER furnished equipment in accordance with the installation instructions, Shop Drawings and submittals provided by the equipment manufacturers and available at the OWNER'S offices for CONTRACTOR'S use.

E. Prior to installation of equipment, all sacking and concrete preparation shall be completed and the Work area shall be maintained in a broom-clean condition during the equipment installation.

F. No equipment and materials shall be altered or repaired, and no burning or welding shall be permitted on any parts having machined surfaces, except by written permission of the ENGINEER.

G. No rigging shall be done from any structure without the permission of the ENGINEER. Responsibility for any damage to the structure resulting from this operation, belongs to CONTRACTOR.

H. Only such equipment and materials as will not damage the structure or equipment and materials shall be used on the Work.

1.6 SPECIAL TOOLS

A. All special tools that are required to assemble, disassemble, repair, and maintain any item of equipment furnished under the terms of this Contract shall be furnished with the equipment. When special tools are provided, they shall be marked or labeled and a list of such tools shall be included with the maintenance and operation instructions for the equipment.

1.7 COORDINATION

A. Take all measurements for Work at the installation sites, verify all subcontractor's and manufacturer's drawings, shall be responsible for the proper installation within the available space of the apparatus specified and shown on the Drawings and shall inform the ENGINEER of any variations and shall submit all proposed changes for review before making any changes.

1.8 SERVICES OF MANUFACTURERS' REPRESENTATIVE

A. Equipment furnished under this project shall include the cost of competent, qualified representatives of manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment and to instruct the OWNER'S operating personnel on operation and maintenance. The training time and additional requirements for furnishing services of manufacturers' representatives are specified in the appropriate Sections. If no time is specified, the training time shall be at least one day. Supervision may be divided into two or more time periods as required by CONTRACTOR'S schedule or as directed by ENGINEER.

B. Upon completion of the equipment installation, submit "Equipment Information Form", Form 11 00 00-A located in Section 01 33 10, Reference Forms. The completed form shall also be included in the individual Operation and Maintenance Manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 73 26

CONNECTIONS TO EXISTING FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Perform all construction necessary to complete connections and tie-ins to existing facilities.

B. Keep existing facilities in operation unless otherwise specifically permitted in these Specifications or approved by OWNER.

C. Perform all construction activities so as to avoid interference with operations of the facility and the work of others.

1.2 BYPASSING

A. Bypassing of plant flow will be permitted only for brief intermittent periods necessary to make the connections, as outlined in Section 01 11 00 Summary of Work.

1.3 SEQUENCING AND OPERATIONS

A. All operations of existing valves and gates required for the Work shall be done by OWNER.

B. Insofar as possible, all equipment shall be tested and in operating condition before the final tie-ins are made to connect equipment to the existing facility.

C. Carefully coordinate all Work and schedules and shall provide OWNER written notice at least 48 hours before shut-downs or by-passes are required.

D. Work Sequence: Sequence of Work and Schedule of Completion is specified under Section 01 32 16.15, Construction Progress Schedule, Section 01 14 16, Coordination with OWNER'S Operations, and shown on the Construction Sequence Diagrams included in the Drawings.

1.4 ELECTRICAL INSTALLATION

A. Insofar as possible, all electrical equipment shall be installed, tested, and in operating condition before the final tie-ins are made to existing infrastructure.

1.5 SUBMITTALS

A. For any tie-ins/connections or required shutdowns to existing mains and systems, the CONTRACTOR shall submit a shutdown/tie-in plan to Water Distribution personnel and Engineering and shall be approved at least two weeks prior to the start of the event. The plan shall include dates, durations, procedures, staffing, and any other information pertinent to shutting down the system and connecting to a new system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes administrative and procedural requirements for the cutting and coring, and rough and finish patching of holes and openings in existing construction.

B. All cutting, coring and rough patching shall be performed by CONTRACTOR requiring the opening. Finish patching shall be the responsibility of CONTRACTOR and shall be performed by the trade associated with the application of the particular finish.

C. Provide cutting, coring, fitting and patching, including attendant excavation and backfill required to complete the Work, or to:
   1. Remove and replace defective Work or Work not conforming to requirements of the Contract Documents.
   2. Remove samples of installed Work as specified or required for testing.
   3. Remove all constructions required to provide for specified alterations or addition to existing work.
   4. Uncover Work to provide for ENGINEER'S observation of covered Work or observation by regulatory agencies having jurisdiction.
   5. Connect to completed Work that was not accomplished in the proper sequence.
   6. Remove or relocate existing utilities and pipes that obstruct the Work in locations where connections must be made.
   7. Make connections or alterations to existing or new facilities.

D. Coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes Work that is directly related to this Section.
   1. Division 2, Existing Conditions through Division 48, Electrical Power Generation, Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.2 QUALITY ASSURANCE

A. Structural Work: Do not cut or patch structural elements in a manner that would change their load-carrying capacity as load-deflection ratio.

B. Operating Elements: Do not cut or patch operating elements in a manner that would result in reducing their capacity to perform as intended. Do not cut or patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.

1.3 SUBMITTALS

A. Submit a written request to ENGINEER well in advance of executing any cutting or alteration which affects:
   1. Design function or intent of Project.
   2. Work of OWNER or any other contractor.
   3. Structural value or integrity of any element of the Project.
   4. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
   5. Efficiency, operational life, maintenance or safety of operational elements.
   6. Visual qualities of sight-exposed elements.

B. Request shall include:
   1. Identification of Project.
   2. Description of affected Work of CONTRACTOR and work of others.
   3. Necessity for cutting.
   4. Effect on work of OWNER or any other contractor, or on structural or weatherproof integrity of Project.
   5. Description of proposed Work, describing:
      a. Scope of cutting and patching.
      b. Trades who will be executing the Work.
      c. Products proposed to be used.
      d. Extent of refinishing.
      e. Schedule of operations.
   6. Alternatives to cutting and patching, if any.
   7. Designation of party responsible for cost of cutting and patching, when applicable.
   8. Written permission of any other contractor whose work will be affected.

C. Should conditions of Work, or schedule, indicate a change of materials or methods, submit written recommendation to ENGINEER, including:
   1. Conditions indicating change.
   2. Recommendations for alternative materials or methods.
   3. Submittals as required for substitutions.

D. Submit written notice to ENGINEER, designating time Work will be uncovered, to provide for observation. Do not begin cutting or patching operations until authorized by ENGINEER.

E. Conform to all applicable specifications for application and installation of materials used for patching.

1.4 WARRANTY

A. Replace, patch and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials in such a manner as to not void required or existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform all cutting and coring in such a manner as to limit the extent of patching.

B. Core drill all holes to be cut through concrete and masonry walls, slabs or arches, unless otherwise approved by the ENGINEER.

3.2 INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed before cutting.

B. Report unsatisfactory or questionable conditions to ENGINEER, in writing. Do not proceed with Work until the ENGINEER has provided further instructions.

3.3 PREPARATION

A. Provide temporary support as required to maintain structural integrity of Project, to protect adjacent Work from damage during cutting, and to support the Work to be cut.

B. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that will be exposed during cutting and patching operations.
   1. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
   2. Do not cut existing pipe, conduit or ductwork serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.4 CORING

A. Perform coring with a non-impact rotary tool using diamond core drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required.

B. Protect existing equipment, utilities and adjacent areas from water and other damage covered by drilling operations.

C. Vacuum or otherwise remove slurry or tailings from the Work area following drilling.

3.5 CUTTING

A. Cut existing construction using methods least likely to damage elements retained or adjoining construction and that will provide proper surfaces to receive installation or repair.
   1. In general, use hand or small power tools designed for sawing or grinding, not hammering and chopping.
   2. Cut through concrete and masonry using a concrete wall saw with diamond saw blades.
      a. Provide for control, on both sides of walls, of slurry generated by sawing.

B. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Provide temporary covering over openings where not in use.

C. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.

D. Provide adequate bracing of area to be cut prior to start of cutting.

E. Provide equipment of adequate size to remove cut panel.

3.6 PATCHING

A. Patch construction by filling, repairing, refinishing, closing-up and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified, in other Sections of these Specifications.

B. Where feasible, test patched areas to demonstrate integrity of installation.

C. Fit Work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

D. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   1. For continuous surfaces, refinish to nearest intersection.
   2. For an assembly, refinish entire unit.

E. Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 CLEANING

A. Clean areas and spaces where cutting, coring and patching are performed. Clean piping, conduit or similar constructions before applying paint or other finishing materials. Restore damaged pipe covering to original condition.

+ + END OF SECTION + +

SECTION 01 74 00

CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Execute cleaning, during progress of the Work, at completion of the Work, and as required by General Conditions. If CONTRACTOR fails to clean areas as specified in this Section, the OWNER will have the areas cleaned and backcharge CONTRACTOR.

1.2 REQUIREMENTS OF REGULATORY AGENCIES:

A. In addition to the requirements herein, maintain the cleanliness of the Work and surrounding premises within the Work limits so as to comply with federal, state, and local fire and safety laws, ordinances, codes and regulations.

B. Comply with all federal, state and local anti-pollution laws, ordinances, codes and regulations when disposing of waste materials, debris and rubbish.

1.3 PROGRESS CLEANING:

A. General: Clean the Site, Work areas and other areas CONTRACTOR is permitted to occupy by Laws and Regulations at least weekly. Dispose of materials lawfully according to Laws and Regulations:
   1. Comply with requirements in NFPA 241, Standard for Safeguarding Construction, Alteration and Demolition Operations, for removal of combustible waste materials and debris.
   2. Do not hold other materials more than three days if the temperature is expected to rise above 80° F.
   3. Provide suitable containers for storage of waste materials and debris.
   4. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

B. Project:
   1. Maintain Project free of waste materials and debris.
   2. Keep exterior dust generating areas wetted down.
   3. Paved roads: Comply with the requirements of Section 01 55 00.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly and report spills to the OWNER and ENGINEER immediately.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire Work area, as appropriate.

D. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only

cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove all debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
   1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

H. Waste Disposal:
   1. Properly dispose of all waste materials, surplus materials, debris and rubbish off the Project site.
   2. Do not burn or bury rubbish and waste materials on the Project site.
   3. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
   4. Do not discharge wastes into streams or waterways.
   5. Sole responsibility for complying with any federal, state, and local environmental and regulations in disposing of waste, belongs to CONTRACTOR.

I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

1.4 FINAL CLEANING

A. General: Provide final cleaning.
   1. Complete the following cleaning and waste-removal operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
      a. Clean and remove from the Project rubbish, waste material, debris, and other foreign substances.
      b. Mechanical sweeping of paved areas. Remove petrochemical spills, stains, and other foreign deposits.
      c. Hose clean sidewalks and loading areas.
      d. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
      e. Leave water courses, gutters, and ditches open and clean.

f. Repair pavement, roads, sod, and all other areas affected by construction operations and restore them to original condition or to minimum condition specified.
g. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
h. Clean, wax and polish wood, vinyl and painted floors.
i. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
j. Sweep concrete floors broom clean in unoccupied spaces.
k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
l. Remove tags and labels that are not permanent.
m. Touch up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.
    1) Do not paint over “UL” or similar labels, including manufacturer mechanical and electrical nameplates.
n. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
r. Maintain the cleaning until OWNER occupies the Project or portion thereof.
s. Leave Project clean and in a neat and orderly condition satisfactory to ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 75 00

STARTING AND PLACING EQUIPMENT IN OPERATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Initially start-up and place all equipment installed into successful operation according to manufacturer's written instructions and as instructed by manufacturer's field representative. Provide all material, labor, tools, equipment, chemicals, lubricants, and expendables required to complete start-up.

B. No system or subsystem shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

C. General Activities Include:
   1. Cleaning.
   2. Removing temporary protective coatings.
   3. Flushing and replacing greases and lubricants, where required by manufacturer.
   4. Lubrication.
   5. Check shaft and coupling alignments and reset where needed.
   6. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
   7. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
   8. All adjustments required.

D. Provide chemicals and lubricants and all other required operating fluids.

E. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.

F. OWNER provide sufficient personnel to assist CONTRACTOR in the start-up, but the prime responsibility for proper mechanical operation shall belong to CONTRACTOR. Manufacturer's representatives shall be present during initial start-up and operation, unless otherwise acceptable to ENGINEER.

G. Start-up of either the heating or air conditioning systems is dependent upon the time of year that the plant start-up is initiated. CONTRACTOR make arrangements with OWNER to return at the beginning of the next heating or air conditioning season (whichever is applicable) to start the appropriate system.

H. No system, unit process or any piece of equipment shall be started up for continuous operation without the approved Operation and Maintenance Manuals being turned over to the OWNER.

I. Training shall be provided prior to turning the operation of a system, unit process or piece of equipment over to the OWNER. Training shall be scheduled for each plant staff work shift accordingly. Training shall conform to the requirements of Section 01 79 00, Instruction of Operations and Maintenance Personnel.

J. Completion of start-up shall be when the OWNER assumes responsibility for operation of the equipment. If the OWNER does not assume operational responsibility and in the opinion of the ENGINEER start-up tasks are completed, the ENGINEER will notify CONTRACTOR, in writing, of the completion of the start-up period.

1.2 MINIMUM START-UP REQUIREMENTS

A. Bearings and Shafting:
1. Inspect for cleanliness, and clean and remove all foreign materials.
2. Verify alignment.
3. Replace defective bearings and those which run rough or noisy.
4. Grease as necessary and in accord with manufacturer's recommendations.

B. Drives:
1. Adjust tension in V-belt drives, and adjust varipitch sheaves and drives for proper equipment speed.
2. Adjust drives for alignment of sheaves and V-belts.
3. Clean and remove foreign materials before starting operation.

C. Motors:
1. Check each motor for comparison to amperage manufacturer nameplate value.
2. Correct conditions which produce excessive current flow and exist due to equipment malfunction.

D. Pumps:
1. Check glands and seals for cleanliness and adjustment before running pump.
2. Inspect shaft sleeves for scoring.
3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
4. Verify that piping system is free of dirt and scale before circulating liquid through the pump.

E. Valves:
1. Inspect both hand and automatic control valves, and clean bonnets and stems.
2. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
4. Replace packing on any valve that continues to leak.
5. Remove and repair bonnets that leak.
6. Coat packing gland threads and valve stems with a surface preparation of "Moly-Cote" or "Fel-Pro" after cleaning.

F. Verify that control valve seats are free from foreign material and are properly positioned for intended service.

G. Tighten flanges and all other pipe joints after system has been placed in operation.
   1. Replace gaskets which show any sign of leakage after tightening.

H. Inspect all joints for leakage.
   1. Promptly remake each joint that appears to be faulty; do not wait for rust to form.
   2. Clean threads on both parts, and apply compound and remake joints.

I. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats and headers in fluid system to assure freedom from foreign materials.

J. Open steam traps and air vents, where used, and remove operating elements.
   1. Clean thoroughly, replace internal parts and put back into operation.

K. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

L. Set and calibrate draft gages of air filters and other equipment.

M. Inspect fan wheels for clearance and balance.
   1. Provide factory-authorized personnel for adjustment when needed.

N. Check each electrical control circuit to assure that operation complies with Specifications and requirements and to provide desired performance.

O. Inspect each pressure gage and thermometer for calibration.
   1. Replace items which are defaced, broken, or which read incorrectly.

P. Repair any damaged insulation.

Q. Vent gasses trapped in any part of systems.
   1. Verify that liquids are drained from all parts of gas or air systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 75 16

EQUIPMENT AND SYSTEM STARTUP AND PERFORMANCE TESTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section contains requirements for CONTRACTOR'S performance in documenting testing Work required under this Contract. In addition, this Section contains requirements for CONTRACTOR'S performance testing during installed startup and performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems. This Section supplements, but does not supersede specific testing requirements, found elsewhere in the Contract Documents.

B. Upon completion of design, CONTRACTOR and ENGINEER shall submit a testing, startup and commissioning plan, and schedule to the OWNER for review and approval prior to any system or equipment startup. There shall be at a minimum of three 4-hour work sessions to work through the development of a thorough testing plan. A draft testing, startup and commissioning plan shall be submitted to the OWNER and ENGINEER for review and comment at 30 percent of project construction. A revised draft of the plan shall be submitted to the OWNER and ENGINEER for review and comment at 60 percent of project construction. A final plan shall be submitted at 90 percent of project construction.

C. Refer to the City of Phoenix Equipment Setup / System Testing Guidance Manual (Guidance Manual) to assist in development of a testing program that will fulfill the requirements of the specifications.

1.2 QUALITY ASSURANCE

A. CONTRACTOR'S Quality Assurance Manager: Appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise CONTRACTOR'S Quality Assurance Program. The Quality Assurance Manager shall have at least five years of total experience, or experience on at least five separate projects, in managing the startup and performance testing of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum four year course in mechanical or civil engineering. Operations specialists shall have equivalent experience in plant operation and maintenance. The quality assurance program shall include:
   1. A testing plan setting forth the sequence in which all testing Work required under the Contract Documents will be implemented.
   2. A documentation program to record the results of all equipment and system tests.
   3. An installed startup and performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this Contract.
   4. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this Contract.
   5. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this

Contract.

6. A testing schedule conforming to the requirements specified in Paragraph 2.2 C., below.

B. For the purposes of this Section, a system shall include all required items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this Section.

C. Calibration:
   1. All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this Contract shall be calibrated and certified to within plus or minus two percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.
   2. Liquid flow meters, including meters installed in pipelines with diameters greater than 2-inches shall be calibrated insitu using either the total count or dye dilution methods, as approved by the ENGINEER. Gas flow meters installed in piping systems with diameters greater than 6-inches shall be calibrated insitu using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus two percent.

D. References:
   1. This Section contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

   3. Equipment Setup / System Testing Guidance Manual should be used as a resource to assist with understanding the detail the OWNER is requiring to

ensure all equipment and systems are operational with respect to the contract documents. The Guidance Manual shows how to assemble a systematic equipment and system testing program that will satisfy the contract requirement. The Guidance Manual shall be used as a tool to assist the development of an equipment setup, testing plans, and documentation binder. The Guidance Manual is not all encompassing requirements. Meaning there are project specification and equipment specific requirement that will need to be added to the document; plus modification to the type of project, refer to project specifications for additional information.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type--Elastic Element
ASTM E77 Thermometers	Method for Verification and Calibration of Liquid-in-Glass
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
City of Phoenix	Guidance Manual Equipment Setup / System Testing Plan

1.3 SUBMITTALS

A. Submit for approval the following:
   1. A complete description of CONTRACTOR'S plan for documenting the results from the test program in conformance with the requirements of Paragraph 2.2.A., below, including:
      a. Proposed plan for documenting the calibration of all test instruments.
      b. Proposed plan for calibration of all instrument systems, including flow /level meters and all temperature, pressure, weight, and analysis systems.
      c. Sample forms for documenting the results of field pressure and performance tests. Forms located in Section 01 33 10– Reference Forms.
      d. A list of all CMMS Tag numbers as provided in Section 01 93 13.15, Computerized Maintenance Management System Tags.
   2. The credentials and certification of the testing laboratory proposed by CONTRACTOR for calibration of all test equipment.
   3. Pre-startup check out procedures, reviewed and approved by the respective equipment manufacturers.
   4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by CONTRACTOR for the systematic startup and performance testing of all equipment and systems installed under this Contract.
   5. A schedule and subsequent updates, presenting CONTRACTOR'S plan for startup and performance testing the equipment and systems installed under this Contract.
   6. A schedule establishing the expected time period (calendar dates) when CONTRACTOR plans to commence performance testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.
   7. A summary of the Quality Assurance Manager's qualifications, conforming to the requirements of Paragraph 1. 2. A, above.

8. All records produced during the startup and testing program.
9. Systems or unit process or any piece of equipment shall not be started up without the approved Operation and Maintenance Manuals being turned over to the OWNER.
10. Written notice to ENGINEER a minimum of 72 hours prior to beginning of any test.

1.4 ADJUSTMENTS

A. Until final tests are completed and approved, make all necessary changes, adjustments and replacements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Prepare test plans and documentation plans as specified in the following paragraphs. The OWNER and ENGINEER will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and approved.

2.2 DOCUMENTATION

A. Documentation Plans:
   1. Equipment Setup / System Testing Guidance Manual format shall be used to develop and document test plans.
   2. Develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.
   3. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for the OWNER'S and ENGINEER'S witnesses and CONTRACTOR'S Quality Assurance Manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:
      a. Metallurgical tests.
      b. Factory performance tests.
      c. Accelerometer recordings made during shipment.
      d. Field calibration tests[1].
      e. Field pressure tests[1].
      f. Field performance tests[1].
      g. Field operational tests[1].

      ([1]Each of these tests are required even though not specifically noted in detailed specification Section.)
   4. Section 01 33 10, Reference Forms, contains samples showing the format and level of detail required for the documentation forms. These are samples only and are not specific to this Project or to any item of equipment or system to be installed under this Contract. Develop test documentation forms specific to each item of equipment and system installed under this Contract. Acceptable

documentation forms for all systems and items of equipment shall be submitted for review by the OWNER and ENGINEER as a condition precedent to CONTRACTOR'S receipt of progress payments in excess of 50 percent of the Contract amount. Once the OWNER and ENGINEER has reviewed and approved the forms proposed by CONTRACTOR, produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this Contract.

B. Test Plans:
   1. Develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this Contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or CMMS Tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:
      a. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.
      b. Calibration of all analysis instruments and control sensors.
      c. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the Contract Documents.
      d. System performance tests designed to duplicate, as closely as possible, operating conditions described in the Contract Documents.
   2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.
   3. As a condition precedent to receiving progress payments in excess of 75 percent of the Contract amount, or in any event, progress payments due to CONTRACTOR eight weeks in advance of the proposed date the CONTRACTOR intends to begin any testing work (whichever occurs earliest in the Project Schedule), have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this Contract. Once the ENGINEER has reviewed and approved CONTRACTOR'S test plans, reproduce the plans in sufficient number for CONTRACTOR'S purposes and an additional ten copies for delivery to the ENGINEER. No test work shall begin until CONTRACTOR delivers the specified number of final test plans to the ENGINEER.
   4. Test Plans shall be developed and formatted according to the Equipment Setup / System Testing Guidance Manual.

C. Testing Schedule: Provide a startup and testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be a CPM format, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with CONTRACTOR'S Progress Schedule specified in Section 01 32 16.15, Construction Progress Schedule. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than four weeks in advance of the date testing

is to begin. The ENGINEER will not witness any testing work for the purpose of acceptance until CONTRACTOR has submitted a test schedule and the ENGINEER approves. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Documents.

D. Binder Format:
   1. Prepare data in the format detailed in the forms provided, forms shall be modified with project specific details.
   2. Binders: Commercial quality, 8-1/2 inch by 11 inch (size A4), three D side ring binders with durable plastic covers; 2 inch (50 millimeter) maximum ring size. Correlate data into related consistent groupings when multiple binders are used,
   3. Cover: Identify each binder with typed project number and name and subject matter of the contents. Titles shall be placed both on the front and binder edge of the binder.
   4. Provide tabbed card stock material for each separate section and subsection, with 1/2in extended tabs and typed description on the tabs for the main sections.
   5. Text: Printed data or type written data on 20 pound, minimum, white punched paper. Computer generated data shall be printed by letter quality 150 dpi resolution printers unless approved otherwise.
   6. Drawings: Provide with reinforced punched binder tab. Bind in with text; Reduce larger drawings and fold to size of text pages but not larger than 11-inches by 17-inches.

2.3 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

A. Each item of mechanical, electrical, instrumentation and HVAC equipment installed under this Contract shall be tested to demonstrate compliance with the performance requirements of the Contract Documents. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this Contract shall be tested in accordance with the requirements of the Contract Documents.

B. Once all equipment and systems have been tested individually, defined in the Guidance Manual as Contractor Testing. Proceed with performance testing in accordance with the requirements of Article 3.3, below, simulating actual operating conditions to the greatest extent possible. Install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. Performance testing is broken in (2) groups of testing in the Guidance Manual, Verification and Demonstration Testing. During the operational testing period, CONTRACTOR'S Quality Assurance Manager and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the ENGINEER.

PART 3 - EXECUTION

3.1 GENERAL

A. Quality Assurance Manager: Organize teams made up of qualified representatives of equipment suppliers, subcontractors, CONTRACTOR'S independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this Contract. The objective of the testing program shall be to demonstrate, to the OWNER'S and ENGINEER'S complete satisfaction, that the structures, systems, and equipment constructed and installed under this Contract meets all performance requirements and the facility is Substantially Complete and ready for the commissioning process to commence. In addition, the testing program shall produce baseline-operating conditions for the OWNER to use in a Preventive Maintenance Program.

3.2 CALIBRATION OF FIXED INSTRUMENTS

A. Calibration of analysis instruments, sensors, gages, and meters installed under this Contract shall proceed on a system-by-system basis. No equipment or system performance test shall be performed until all instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the OWNER and ENGINEER.

3.3 EQUIPMENT SETUP / SYSTEM TESTING

A. General:
   1. Supplier Equipment Setup, Calibration, and Checkout: shall consist of but not limited to Pressure or leakage tests ,Electrical testing as specified in Division 26, Electrical, Wiring and piping, individual component, loop, loop commissioning and tuning testing, as specified in Division 40, Process Interconnections, Pre-startup check out for all mechanical and HVAC equipment. Pre-startup check out procedures shall be reviewed and accepted by the respective equipment manufacturer. Supplier Equipment Setup, Calibration, and Checkout is further explained in the Guidance Manual.
   2. Contractor testing: shall consist of but not be limited to the individual and system tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems shall demonstrate compliance with the performance requirements of the Contract Documents to the CONTRACTOR. Contractor testing is further explained in the Guidance Manual.
   3. Verification Testing: To verify to the Owners Representative that all equipment and systems will function as designed. The Verification Testing is to be designed to duplicate, as closely as possible, the operating design. Verification testing is further explained in the Guidance Manual.
   4. Demonstration Testing: To show the Owner all equipment as a system will function as designed. The testing will simulate various operating conditions to allow the system as a whole to react. The plan will clearly show the system works in various conditions as described in the Control descriptions and detailed in the Process and Instrumentation drawings. Demonstration testing is further explained in the Guidance Manual.

B. Testing for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the ENGINEER after receipt of a written request, complete with justification for the change in sequence.

C. Pressure and Leakage Tests: Pressure and leakage tests shall be conducted in accordance with applicable Sections. All acceptance tests shall be witnessed by the ENGINEER. Evidence of successful completion of the pressure and leakage tests shall be the ENGINEER'S signature on the test forms prepared by CONTRACTOR.

D. Equipment Checkout: Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the requirements of Division 26, Electrical.

E. Component Calibration and Loop Testing: Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested, as specified in Division 40, Process Interconnections.

F. Electrical Resistance: Electrical resistance testing shall be in accordance with the requirements of Division 26, Electrical.

G. Pre-Startup Tests: Pre-startup tests shall include the following:
   1. Alignment of equipment using reverse dial indicator method.
   2. Pre-operation lubrication.
   3. Tests in accordance with the manufacturers' recommendations for pre-start preparation and pre-operational check out procedures.

   4. Pre-Startup tests shall conform to the requirements of Section 01 75 00, Starting and Placing Equipment in Operation.

H. System Performance Tests
   1. System Performance Tests are broken in to (2) groups of tests, Verification and Demonstration testing. Refer to the Guidance Manual for further definition of how to develop System Performance Tests.
   2. General: Once all affected equipment has been subjected to the required pre-operational check out procedures and the ENGINEER has witnessed and has not found deficiencies in that portion of the Work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine, as nearly as possible, whether the equipment and systems meet the requirements of these specifications.
   3. For each system performance test phase, the equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls and shall last no less than 3 continuous days. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system, at no additional cost to the OWNER. Disposal methods for test media shall be subject to review and approval by the OWNER and ENGINEER. During the performance test period, obtain baseline-operating data on all equipment with motors greater than one horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the OWNER to enter in a Preventive Maintenance Program.
   4. Test results shall be within the tolerances set forth in the detailed specification Sections of the Contract Documents. If no tolerances have been specified, test

results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory performance test, any doubt, dispute, or difference should arise between the ENGINEER and CONTRACTOR regarding the test results or the methods or equipment used in the performance of such test, then the ENGINEER may order the test to be repeated. If the repeat test, using such modified methods or equipment as the ENGINEER may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the OWNER. Otherwise, the costs shall be borne by CONTRACTOR. Where the results of any performance test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by CONTRACTOR at his expense.

5. Provide, at no expense to the OWNER, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.
6. Should the testing period be halted for any reason, the operational testing program shall be repeated, until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, flow and level.
7. Record Documents shall conform to the requirements of Section 01 78 39, Project Record Documents, of facilities involved shall be accepted and ready for turnover to the OWNER 72 hours prior to operational testing.
8. Phase Retesting: If under test, any portion of the Work should fail to fulfill the Contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the Work as are affected thereby, shall, unless otherwise directed by the ENGINEER, be repeated within reasonable time and in accordance with the specified conditions. Pay to the OWNER all reasonable expenses incurred by the OWNER, including the costs of the ENGINEER, as a result of repeating such tests.
9. Post-Test Inspection: Once testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the ENGINEER. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the ENGINEER, at no additional cost to the OWNER.
10. After the CONTRACTOR has demonstrated and proven to the ENGINEER that all system are functioning properly and has been documented in the approved testing and startup plan, then the CONTRACTOR shall demonstrate this reliability to the OWNER. The OWNER demonstration shall be executed as agreed upon and documented per the approved testing and startup plan.

I. Operational Availability Demonstration, defined as Commissioning in the Guidance Manual.

1. Operational Availability Demonstration (OAD) shall begin following completion of the integrated system field test as specified above and shall continue until a time frame has been achieved wherein the equipment, instrumentation and control system hardware availability meets or exceeds 99.7 percent for 7 consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the system shall be available to plant operating personnel for use in normal operation of the Plant.
2. For the purpose of the Operational Availability Demonstration, the system shall be defined as consisting of the following systems and components:
   a. Solids handling wet well pumps, associated piping, valves and miscellaneous equipment
   b. Ferrous Chloride storage and pumping system
   c. Odor control/biofilter System
   d. Site security, lighting and other operations requiring electrical service

3. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The Operational Availability Demonstration shall be terminated if one or more of these conditions occur. Following correction of the problem, a new 7 consecutive day OAD shall begin.
   a. Failure to repair a hardware or software problem within 120 consecutive hours from the time of notification of a system failure.
   b. Recurrent hardware problems: If the same type of problem occurs three times or more.
4. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.5.E., below
   a. Failure of new equipment
   b. Loss of communications between devices on the communications network.
   c. Failure of one or more input/output components.
   d. Failures of any type affecting ten or more input/output points simultaneously.
   e. Failure of any type affecting one or more regulatory control loops or sequential control strategies thereby causing a loss of the automatic control of the process variable or process sequence operation.
   f. Failure of power supply. Where redundant power supplies are provided, failure of one power supply shall not constitute a system failure provided the backup power supply operates properly and maintains supply power. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.
5. The system availability shall be calculated based on the following equation:

$$A = \frac{MTBF}{MTBF + MTTR} \times 100\%$$

   Where:
   A = system availability in percent
   MTBF = average time interval between consecutive system failures
   MTTR = mean time required to repair system failures

6. Time between failures shall be the period between the time that a reported system failure has been corrected and the time of subsequent notification of

CONTRACTOR that another system failure has occurred in terms of operating hours.

7. Time to repair shall be the period between the time that CONTRACTOR is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.
   a. Actual travel time for service personnel to get to the plant site up to a maximum of six hours from the time CONTRACTOR is notified of a system failure.
   b. Time for receipt of spare parts to the plant site once requested up to a maximum of 24 hours. No work shall be done on the system while waiting for delivery of spare parts.
   c. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.
8. Completion of a 7 consecutive day period without any restarts of the OAD and with a system availability in excess of 99.7 percent will constitute acceptance of the System by OWNER.
9. Submit a request of acceptance after 7 consecutive day period without any restarts to the ENGINEER for approval.
10. All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by CONTRACTOR, at no additional cost to OWNER. If parts are obtained from the contractual spare parts inventory, they shall be replaced to provide a full complement of parts as specified.
11. A System Malfunction/Repair Reporting Form shall be completed by the OWNER and ENGINEER to document system failures, to record CONTRACTOR notification, arrival and repair times and CONTRACTOR repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

+ + END OF SECTION + +

SECTION 01 76 00

PROTECTING INSTALLED CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall be responsible for taking all precautions, providing all programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage as specified in the General Conditions and herein.

B. In order to prevent damage, injury or loss, CONTRACTOR'S actions shall include, but not be limited to, the following:
   1. Store apparatus, materials, supplies, and equipment in an orderly, safe manner that will not unduly interfere with the progress of the Work or the work of any other contractor or utility service company.
   2. Provide suitable storage facilities for all materials which are subject to injury by exposure to weather, theft, breakage, or otherwise.
   3. Place upon the Work or any part thereof only such loads as are consistent with the safety of that portion of the Work.
   4. Clean up frequently all refuse, rubbish, scrap materials, and debris caused by his operations, to the end that at all times the site of the Work shall present a safe, orderly and workmanlike appearance.
   5. Provide barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, elevated walkways and other hazardous areas.

C. CONTRACTOR shall not, except after written consent from proper parties, enter or occupy privately-owned land with personnel, tools, materials or equipment, except on easements provided herein.

D. CONTRACTOR shall assume full responsibility for the preservation of all public and private property or facility on or adjacent to the site. If any direct or indirect damage is done by or on account of any act, omission, neglect or misconduct in the execution of the Work by CONTRACTOR, it shall be restored by CONTRACTOR, at his expense, to a condition equal to that existing before the damage was done.

E. CONTRACTOR shall be responsible for any staking/roping needed to identify the contractual limits of construction activities.

1.2 BARRICADES AND WARNING SIGNALS

A. Where Work is performed on or adjacent to any roadway, right-of-way, or public place, provide barricades, fences, lights, warning signs, danger signals, watchmen, and shall take other precautionary measures for the protection of persons or property and of the Work. Barricades shall be painted to be visible at night. From sunset to sunrise, furnish and maintain at least one light at each barricade.

Sufficient barricades shall be erected to keep vehicles from being driven on or into Work under construction. Furnish watchmen in sufficient numbers to protect the Work. CONTRACTOR'S responsibility for the maintenance of barricades, signs, lights, and for providing watchmen shall continue until the Project is accepted by OWNER.

1.3 TREE AND PLANT PROTECTION

A. Protect existing trees, shrubs and plants on or adjacent to the site that are shown or designated to remain in place against unnecessary cutting, breaking or skinning of trunk, branches, bark or roots.

B. Materials or equipment shall not be stored or parked within the drip line.

C. Temporary fences or barricades shall be installed to protect trees and plants in areas subject to traffic.

D. Fires shall not be permitted.

E. Within the limits of the Work, water trees and plants that are to remain, in order to maintain their health during construction operations.

F. Cover all exposed roots with burlap which shall be kept continuously wet. Cover all exposed roots with earth as soon as possible. Protect root systems from mechanical damage and damage by erosion, flooding, run-off or noxious materials in solution.

G. If branches or trunks are damaged, prune branches immediately and protect the cut or damaged areas with emulsified asphalt compounded specifically for horticultural use in a manner approved by the ENGINEER.

H. All damaged trees and plants that die or suffer permanent injury shall be removed and disposed of off-site when ordered by the ENGINEER and replaced by a specimen of equal or better quality.

I. Coordinate Work in this Section with requirements of Section 02 41 00, Demolition, and Section 31 10 00, Site Clearing.

J. Erect and maintain temporary construction fence to protect area from construction traffic and activities.

1.4 PROTECTION OF EXISTING STRUCTURES

A. Underground Structures:
   1. Underground structures are defined to include, but are not limited to, all sewer, water, gas, and other piping, and manholes, chambers, electrical conduits, tunnels and other existing subsurface work located within or adjacent to the limits of the Work.
   2. All underground structures known to ENGINEER, except water, gas, sewer, electric, and telephone service connections, are shown. This information is

shown for the assistance of CONTRACTOR, in accordance with the best information available, but is not guaranteed to be correct or complete.

3. Explore ahead of trenching and excavation Work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption to the services which such structures provide. If CONTRACTOR damages an underground structure, he shall restore it to original condition at his expense.
4. Necessary changes in the location of the Work may be made by ENGINEER to avoid unanticipated underground structures.
5. If permanent relocation of an existing underground structure or other subsurface facility is required and is not otherwise provided for in the Contract Documents, ENGINEER will direct CONTRACTOR, in writing, to perform the Work, which shall be paid for under the provisions of the General Conditions.

B. Surface Structures:
1. Surface structures are defined as all existing buildings, structures and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage, piping, poles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

C. Protection of Underground and Surface Structures:
1. Sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure. Before proceeding with the Work of sustaining and supporting such structure, satisfy the ENGINEER that the methods and procedures to be used have been approved by the party owning same.
2. Assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the limits of the Work. Be responsible for all damage and expense for direct or indirect injury caused by his Work to any structure. Repair immediately all damage caused by his Work, to the satisfaction of the owner of the damaged structure.

D. All other existing surface facilities, including but not limited to, guard rails, posts, guard cables, signs, poles, markers, and curbs, which are temporarily removed to facilitate installation of the Work, shall be replaced and restored to their original condition at CONTRACTOR'S expense.

1.5 PROTECTION OF FLOORS AND ROOFS

A. Protect floors and roofs during entire construction period.

B. Proper protective covering shall be used when moving heavy equipment, handling materials or other loads, when painting, handling mortar and grout and when cleaning walls and ceilings.

C. Use metal pans to collect all oil and cuttings from pipe, conduit, or rod threading machines and under all metal cutting machines.

D. Concrete floors less than 28 days old shall not be loaded without written permission of the ENGINEER. No floor, roof or slab shall be loaded in excess of its design loading.

E. Roofs shall not be loaded without written permission of the ENGINEER.

F. Restrict access to roofs and keep clear of existing roofs, except as required by the Work.

G. If access to roofs is required, roofing, parapets, openings and all other construction on or adjacent to roof shall be protected with suitable plywood or other approved means.

1.6 PROTECTION OF INSTALLED PRODUCTS AND LANDSCAPING

A. Provide protection of installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed prior to completion of Work.

B. Control traffic to prevent damage to equipment, materials and surfaces.

C. Provide coverings to protect equipment and materials from damage.
   1. Cover projections, wall corners and jambs, sills and soffits of openings, in areas used for traffic and for passage of products in subsequent work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Operating and Maintenance Data in the form of instructional manuals for use by the OWNER'S personnel for:
   1. All equipment and systems.
   2. All valves, gates and related accessories.
   3. All instruments and control devices.
   4. All electrical gear.

B. Training or start-up on any system, process, or piece of equipment shall **not** be allowed until Operating and Maintenance Manuals are reviewed by the ENGINEER and the Operating and Maintenance Manuals have been turned over and approved by OWNER.

C. Operating and Maintenance Data:
   The term "Operating and Maintenance Data" includes all product related information and documents which are required for preparation of the operating and maintenance manual. It also includes all data which shall accompany said manual as directed by current regulations of any participating government agency.
   1. Required Operation and Maintenance Data includes, but is not limited to, the following:
      a. A copy of the specification section in which the Operations and Maintenance Manual applies.
      b. Complete, detailed written operating instructions for each product or piece of equipment including equipment function; operating characteristics; limiting conditions; operating instructions for startup, normal and emergency conditions; regulation and control; and shutdown.
      c. Complete, detailed written preventive maintenance instructions as defined below.
      d. Recommended spare parts lists, by generic title and identification number, and local sources of supply for parts.
      e. Written explanations of all safety considerations relating to operation and maintenance procedures, including Material Safety Data Sheets (M.S.D.S.'s).
      f. Provide the completed Equipment Manufacturer/Vendor/Installer Form. Form to include: name, address, phone number, fax number, e-mail address, and website of manufacturer, manufacturer's local service representative (at a minimum), and subcontractor or installer. Form is located in Section 01 33 10 – Reference Forms, form number 01600-C. If multiple manufacturers of equipment are provided in a single manual, provide a separate form for each.

g. Copy of warranty bond and service contract, as applicable.
h. As-built circuit diagrams, wiring diagrams, schematics and functional drawings, as applicable, and either a nameplate drawing or a copy of nameplate.
i. Control Panel Drawings as required by Specification 40 67 00 are to be provided in hard copy and electronically in AutoCAD version 2004 or newer.
j. Final test data, where applicable, shall be submitted as an appendix when completed.
k. Disassembly, reassembly, installation, alignment, adjustment, and checking instructions.
l. Provide installation data in accordance with Section 01 73 19, Installation Data.
m. Written reference to CMMS Tag number, as specified under Section 01 75 16, Equipment and System Startup and Performance Testing, paragraph 1.3.A.1.d., and as provided in Section 01 93 13.15, Computerized Maintenance Management System Tags.
n. Form is located in Section 01 33 10 – Reference Forms, form number 01600-A. If multiple manufacturers of equipment are provided in a single manual, provide a separate data sheet for each.
o. Provide a completed O&M Manual Review – Form is located in Section 01 33 10 – Reference Forms, form number 01781-B – Operations & Maintenance Data Review Check List.
p. Material Safety Data Sheets (M.S.D.S.'s) for all fluids, oils, chemicals, and volume of each liquid used by each piece of equipment being supplied.
q. Provide certificate of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-04-119.

1.2 SUBMITTALS

A. Format Requirements:
1. Use 8-1/2-inch by 11-inch quality paper of a minimum 20 pound. Larger drawings or illustrations are acceptable if neatly folded to the size of 8-1/2-inch by 11-inch and each drawing or illustration placed inside of an individual clear plastic or vinyl sheet protector.
2. All text must be legible typewritten, or machine printed originals or high quality copies of same. Manuals that contain copies that are not clear, not completely legible, off-center, skewed, or where text or drawings are cut by the binding holes shall be subject to disapproval. Pages that contain approval or date stamps, comments or other markings that cover any portion of text or drawing are unacceptable. Electronically transmitted facsimile (fax) copies are also unacceptable.
3. Each page shall have a binding margin of approximately 1-1/2-inches and be punched for placement in a "D-ring" loose-leaf binder. Provide minimum 1-inch size, not larger than 3-inches, white in color, D-ring binders. Binders shall not be filled to more than 3/4 maximum of their capacity.
4. Identify each binder by using the City of Phoenix Templates provided located in Section 01 33 10– Reference Forms, form numbers 001 78 23-C, D, E and F.

Identification shall be included on the Cover Page, Binder Spine, Title Page, Table of Contents and CD Label Non-uniform binders will not be acceptable.
   a. Title "OPERATING AND MAINTENANCE INSTRUCTIONS".
   b. Enter Facility and Project Name in Template.
   c. Enter Specification Section Number and Title in Template.
   d. Enter Name(s) of the Provider of the Manual in Template.
   e. Enter WSD WS Project Number in Template.
5. Coordinate with the ENGINEER and OWNER to develop a comprehensive, practical, and consistent indexing system for the Operating and Maintenance Manuals. The ENGINEER and the OWNER shall review the indexing system before any manuals are submitted in draft form.
6. Use dividers and indexed tabs between major categories of information such as operating instructions, preventive maintenance instructions, or other. When necessary, place each major category in a separate binder.
7. Provide a Table of Contents for each binder using the provided City of Phoenix Template located in Section 01 33 10– Reference Forms, form number 01 78 23-E. The Table of Contents will have an appendix place holder for the final Test Data Forms. The soft copy content shall be identical to the hard copy's Table of Contents.
8. Identify products by their functional names in the table of contents and at least once in each chapter or Section. Thereafter, abbreviations and acronyms may be used if their meaning is explained in a table in the back of each binder. Use of model or catalog numbers or letters for identification is not acceptable.
9. Indicate all components of the equipment on catalog pages by highlighting or some other clearly definable medium for ease of identification.

B. Submittal Requirements
   1. Submit operating and maintenance data to the ENGINEER within 14 days after approval of Shop Drawings, unless noted otherwise.
   2. Final approval of all O&M Manuals will only be provided after the OWNER's DOCUMENTS MANAGER has reviewed and approved the individual final O&M Manuals. A copy of the signed Final Approval checklist shall be included in the O&M Manuals provided to the OWNER.
   3. Preliminary Copies to:
      a. Number of preliminary copies: One Soft Copy (CD/PDF) of each O&M Manual (except for field test data) shall be submitted to the ENGINEER for review. The O&M Manual shall conform to the requirements as specified herein.
      b. Each preliminary O&M Manual must be submitted to and reviewed by ENGINEER and approved by the OWNER 14 days prior to equipment start-up. ENGINEER to determine timeline for the submittal review process.
   4. Final Copies:
      a. Number of Final Copies: One Hard Copy and One Soft Copy (CD/PDF) of each manual.
      b. 14 days prior to placing the equipment into service submit all final hard copies and soft copies of the approved O&M Manual to the ENGINEER.
      c. Soft Copy shall be in, "PDF" format on CD – including "character

recognition (OCR)" and shall include all information provided in hard copy. The PDF file shall be a complete electronic copy of the hardcopy with bookmarks set for each tab in the hardcopy. The PDF file shall include the Cover Page, Binder Spine, Title Page and Table of Contents (use provided City of Phoenix Templates,) to be labeled with Facility Name, WS Number, Project Title, Manual Title, Specification Section and Volume Number, if applicable. Volumes shall be organized in a rational manner with the separation at a bookmark tab and must also be properly labeled with the following: Facility Name, WS Number, Project Title, Manual Title, Specification Section and Volume Number. Must be computer generated. Hand written labels are not acceptable.

C. Operating and Maintenance Data Requirements, in addition to requirements within the listed Sections/Specifications, but are not limited to, the following:
   1. Provide a completed O&M Manual Review Form is located in Section 01 33 10– Reference Forms, form number 01 78 23-A – Operating & Maintenance Data Review Check List completed by CONTRACTOR.
   2. TAB 1 - A copy of the Specification Section for which the Operating and Maintenance (Product/Equipment) Manual applies. Also, include product data sheet or catalog cut sheet.
   3. TAB 2 - Provide the completed Equipment Information Forms, in accordance with the requirements of Section 11 00 00, General Equipment Provisions. Form is located in Section 01 33 10– Reference Forms, form number 11 00 00-A. If multiple manufacturers of equipment are provided in a single manual, provide a separate data sheet for each.
   4. TAB 3 - Provide the completed Equipment Manufacturer/Vendor/Installer Form. Form to include: name, address, phone number, fax number, e-mail address, and website of manufacturer, manufacturer's local service representative (at a minimum), and subcontractor or installer. Form is located in Section 01 33 10– Reference Forms, form number 11 00 00-C. If multiple manufacturers of equipment are provided in a single manual, provide a separate form for each.
   5. TAB 4 - Written reference to CMMS Tag number, as specified under Section 01 75 16.
   6. TAB 5 - Equipment and System Startup and Performance Testing, paragraph 1.3.A.1.d., and as provided in Section 01 93 13.15, Computerized Maintenance Management System Tags.
   7. TAB 6 - Copy of Warranty Bond and Service Contract, as applicable and Unit of Responsibility Certification Form 11 00 00-B and Manufacturer's Installation Certification form 011 05 00-A as with the requirements of Section 011 00 00. Forms are located in Section 01 33 10– Reference Forms.
   8. TAB 7 - Copy of As-built circuit diagrams, wiring diagrams, schematics and functional drawings, as applicable, and either a nameplate drawing or a copy of nameplate.
   9. Control Panel Drawings as required by Specification 40 67 00 are to be provided in hard copy and electronically in AutoCAD version 2017 or newer.
   10. TAB 8 - Complete, detailed written operating instructions for each product or piece of equipment including equipment function; operating characteristics; limiting conditions; operating instructions for startup, normal and emergency

conditions; regulation and control; and shutdown.

11. TAB 9 - Complete, detailed Preventive Maintenance Instructions include, but are not limited to, the Preventive maintenance data to be submitted as required by Section 01 78 23, Preventive Maintenance Data Submittal Form 01 78 23.19-A.
12. TAB 10 - Personnel Maintenance Lesson/Training Plan Spec 01 79 00, and Manufacturer's Instruction Certification Forms 01 79 00-A & 01 79 00-B.
13. TAB 11 - Recommended spare parts lists, by generic title and identification number, and local sources of supply for parts.
14. TAB 12 - Written explanations of all safety considerations relating to operating and maintenance procedures.
15. TAB 13 – Provide Safety Data Sheets (S.D.S.'s) for all fluids, oils, chemicals, and volume of each liquid used by each piece of equipment being supplied.
16. TAB 14 - Provide installation data in accordance with Section 01 73 19, Installation.
17. TAB 15 - Final test data, where applicable, shall be submitted as an appendix when completed.
18. Mark-ups and highlighting of content are acceptable to identify all components of the equipment on catalog pages or on any other applicable documentation from Tabs 1 thru 15.

D. Changes After Installation:
   1. Final test data, changes and/or upgrades made to the systems after initial installation and during the start-up and commissioning phases, including equipment information and as-built wiring schematics, shall be submitted as an appendix to the Operating and Maintenance Manuals.
   2. Copies of all revised Shop Drawings and Documentation that represent changes made during start-up and commissioning shall be submitted to the ENGINEER to replace initial drawings and documentation contained in the Operating and Maintenance Manuals.

1.3 OPERATING AND MAINTENANCE

A. Operating and Maintenance data shall be provided including, but not limited to, for the following equipment.

Equipment	*Specification Section*
Packaged Rooftop Air Conditioning Units - Single Zone	23 74 11
Low Voltage Electrical Power Conductors and Cables	26 05 19
Instrumentation Cable	26 05 19.11
Grounding Systems	26 05 26
Pull Boxes	26 05 33.1
Conduit For Electrical Systems	26 05 33.13
Flexible Conduit	26 05 33.15
Pull Boxes	26 05 33.17

Outlet Boxes	26 05 33.18
Cable Trays for Electrical Systems	26 05 36
Sleeves and Sleeve Seals for Electrical Raceways and Cabling	26 05 44
Expansion - Deflection Fittings	26 05 44.11
Power System Sudies	26 05 73
Power Monitoring System	26 09 13
Lighting Control Devices	26 09 23
Combination Magnetic Motor Starters	26 18 49
Service Entrance Section	26 21 00
Low Voltage Drawout Switchgear	26 23 10
Low Voltage Distribution Switchboards	26 24 10
Panelboards	26 24 16
Receptacles	26 27 26.10
Snap Switches	26 27 26.15
Disconnect Switches	26 28 15
Control Stations	26 29 13.15
480 Volt Standby Power Generator System	26 32 13.10
Static Uninterruptible Power System	26 33 53
Automatic Transfer Switches	26 36 23
Surge Protection Devices	26 43 00
Security System Cable	28 05 46
Integrated Security Management System - Enclosures	28 14 19
CCTV System	28 20 00
Digital Video Management System	28 23 00
Integrated Security Management System	28 30 00
Security Gate Operator	32 31 11
Electrical Manholes and Handholes	33 71 19.13
Underground Duct Banks	33 71 19.24
Dry Type Transformers	33 73 23
Gate Valves Operators and Appurtenances	40 05 61
Eccentric Plug Valves, Operators and Appurtenances	40 05 62
Thermoplastic Valves Operators and Appurtenances	40 05 66
Specialty Valves and Appurtenances	40 05 73
Fiberglass Reinforced Plastic Duct and Accessories	40 10 15
Process Control Descriptions	40 61 96
Process Control System Panels and Enclosures	40 67 00
PLC's - Software and Programming	40 68 70
Process Control System Primary Sensors and Field Instruments	40 70 00

Variable Frequency Drives	40 97 00
Submersible/Immersible Liquid Pumps	43 25 00
Electric Motors Larger than 250 Horsepower	43 28 13
Inorganic Solid Media Biofilter	44 31 21.23

1.4 OPERATING AND MAINTENANCE TRANSMITTAL FORM

A. Upon receipt of the Vendor Operating & Maintenance Manual from the Manufacturer /Supplier, complete the ENGINEER section of Form 01 78 23-B and the Submittal Transmittal Form 01 33 23.10-A as specified in Section 01 33 10 and submit to the CITY PROJECT MANAGER. CITY PROJECT MANAGER to complete Form 01 78 23-B and deliver to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

CITY OF PHOENIX WSD:
PROJECT NAME:
PROJECT NUMBER:

DATE:	O&M MANUAL TITLE:
REV BY:	FACILITY:
JOA#:	PROCESS AREA:
JOC#:	SPECIFICATION #:
PREP BY:	EQUIP MAN:

OPERATING & MAINTENANCE DATA REVIEW CHECKLIST

Form 01 78 23-A

FOR CONTRACTOR USE ONLY

REQUIRED DATA			Item Complete	Item Incomplete	Comment No.	Applicable Page(s)
GENERAL FORMAT						
O&M Format	Paper Quality	*01 78 23-1.2.A.2*	☐	☐		
	Typed/Printed Originals	*01 78 23-1.2.A.3*	☐	☐		
	D-Ring Binder/Triple Post	*01 78 23-1.2.A.4*	☐	☐		
	Binder Identification	*01 78 23-1.2.A.5*	☐	☐		
	Index Tabs - Hard & Soft PDF/CD Indexed & OCR	*01 78 23-1.2.A.6*	☐	☐		
	Dividers	*01 78 23-1.2.A.7*	☐	☐		
	Table of Contents	*01 78 23-1.2.A.8*	☐	☐		
	Full Equipment Names/Identification In Table of Contents & Each Section	*01 78 23-1.2.A.9*	☐	☐		
	Equipment Component Identification on Catalog Pages	*01 78 23-1.2.A.10*	☐	☐		
O&M Tabs	OPERATIONS & MAINTENANCE DATA					
Checklist A	Checklist Form 01 78 23-A	*01 78 23-1.2.C.1* *01 33 10 Form 01 78 23-A*	☐	☐		
Checklist B	Checklist Form 01 78 23-B	*01 78 23-1.4.A*	☐	☐		

REQUIRED DATA			Item Complete	Item Incomplete	Comment No.	Applicable Page(s)
Tab 1	Copy of Applicable Product/Equipment Specification Section	01 78 23-1.2.C.2	☐	☐		
Tab 2 & 3	Manufacturer/Vendor/Installer & Equipment Information Forms	01 78 23 -1.2.C.3 & 01 33 10 Forms 26 05 01-A & C	☐	☐		
Tab 4	CMMS Tag Number Reference Spec 01 93 13.15	*01 78 23.1.2.C.5*	☐	☐		
Tab 5	Equipment, System Startup, Performance Testing / Spec 01 75 16	*01 78 23.1.2.C.6*	☐	☐		
Tab 6	Warranty Bond & Service Contract General Conditions Guaranty-Warranty Spec 11 00 00	*01 78 23-1.2.C.7 Form 26 05 01-B 01 33 10 Form 01 73 19-A*	☐	☐		
Tab 7	Record Documents – Name Plate "As Built, Diagrams etc." Information Spec 01 78 39	*01 78 23-1.2.C.8*	☐	☐		
Tab 7	CAD Drawings - CD & Hard (in Sleeves) AutoCAD Version 2017 or Newer / Spec 25 14 25	*01 78 23-1.2.C.8*	☐	☐		
Tab 8	Product/Equipment Operating Instructions, Conditions, Characteristics	*01 78 23-1.2.C9*	☐	☐		
Tab 9	Preventive Maintenance Instructions Spec 01 78 23.19	*01 78 23-1.2.C.10 01 33 10 Form 01 78 23.19-A*	☐	☐		
Tab 10	Personnel Maintenance Lesson/Training Plan / Spec 01 79 00	*01 78 23-1.2.C.11 Form 01 79 00-A 01 33 10 Form 01 79 00-B*	☐	☐		
Tab 11	Spare Parts, Lists/Supply Sources	*01 78 23-1.2.C.12*	☐	☐		
Tab 12	Safety Precautions /Maintenance Procedures	*01 78 23-1.2.C.13*	☐	☐		
Tab 13	Safety Data Sheets (S.D.S) and Volume for all fluids, oils, chemicals	*01 78 23-1.2.C.14*	☐	☐		
Tab 14	Installation Data / Spec 01 73 19	*01 78 23-1.2.C.15*	☐	☐		
Tab 15	Final Test Data	*01 78 23-1.2.C.16 01 78 23-1.2.D.1 & 2*	☐	☐		

Contractor **Date**

PRINT

CITY OF PHOENIX WSD:
PROJECT NAME:
PROJECT NUMBER:

OPERATING & MAINTENANCE MANUAL REVIEW CHECKLIST *Form 01 78 23-B*

O&M Manual Title:

JOC / JOA #: Engineering Firm:

Manufacturer: Specification No.:

NOT FOR CONTRACTOR USE, ENGINEER ONLY

O&M TAB	ITEM	REVIEW DESCRIPTION	ENGINEER			CITY WSD PROJECT MANAGER		
			Yes	No	N/A	Yes	No	N/A
FORMAT REQUIREMENT	1	Uniform Binder Formatting and Identification (Cover, Spine, Title Page and Table of Contents, CD-Templates)	☐	☐	☐	☐	☐	☐
FORMAT REQUIREMENT	2	Equipment Name/Component Identification on Catalog Pages	☐	☐	☐	☐	☐	☐
CHECKLIST A	3	Completed/Signed Checklist Form 01 78 23-A	☐	☐	☐	☐	☐	☐
CHECKLIST B	4	Completed/Signed Checklist Form 01 78 23-B	☐	☐	☐	☐	☐	☐
TAB 1	5	Copy of Product/Equipment Specification	☐	☐	☐	☐	☐	☐
TAB 2	6	Information Form 11 00 00-A	☐	☐	☐	☐	☐	☐
TAB 3	7	Equipment Manufacturer/Vendor/Installer Form 11 00 00-C	☐	☐	☐	☐	☐	☐
TAB 4	8	Reference to CMMS Tag Number per Spec 01 93 13.15	☐	☐	☐	☐	☐	☐
TAB 5	9	Equipment/Startup/Performance Testing per Spec 01 75 16	☐	☐	☐	☐	☐	☐
TAB 6	10	Warranty Bond/Service Contract Information Spec 11 00 00	☐	☐	☐	☐	☐	☐
	11	Unit of Responsibility Certification Form 11 00 00-B	☐	☐	☐	☐	☐	☐
	12	Manufacturer's Installation Certification Form 11 00 00-A	☐	☐	☐	☐	☐	☐
TAB 7	13	As Built, Control Panel and Wiring Diagrams, Drawings, hard and electronic in AutoCAD version 2017 or newer per Spec 25 14 25	☐	☐	☐	☐	☐	☐
TAB 8	14	Operating Characteristics, Startup, Limiting, Normal and Emergency Conditions, Regulation & Control, Shutdown	☐	☐	☐	☐	☐	☐
TAB 9	15	Preventive Maintenance Instructions per Spec 01 78 23.19	☐	☐	☐	☐	☐	☐
	16	Preventive Maintenance Data Submittal Form 01 78 23.19-A	☐	☐	☐	☐	☐	☐
TAB 10	17	Personnel Maintenance Lesson/Training Plan Spec 01 79 00	☐	☐	☐	☐	☐	☐
	18	Manufacturer's Instruction Certification Forms 01 79 00-A &B	☐	☐	☐	☐	☐	☐
TAB 11	19	Identify Parts, Spare Parts, Supply List and Local Source	☐	☐	☐	☐	☐	☐
TAB 12	20	Safety Precautions and Maintenance Procedures	☐	☐	☐	☐	☐	☐
TAB 13	21	S.D.S. Sheets and volume of each for all fluids, oils, chemicals	☐	☐	☐	☐	☐	☐
TAB 14	22	Installation Data per Spec 01 73 19	☐	☐	☐	☐	☐	☐
TAB 15	23	Final Test Data per Spec 01 78 23-1.2.C.1, D.1 & 2	☐	☐	☐	☐	☐	☐

OPERATING & MAINTENANCE MANUAL REVIEW
CHECKLIST Form 01 78 23-B

NOTES

CITY OF PHOENIX WSD:
PROJECT NAME:
PROJECT NUMBER:

DATE:	O&M MANUAL TITLE:
REV BY:	FACILITY:
JOA#:	PROCESS AREA:
JOC#:	SPECIFICATION #:
PREP BY:	EQUIP MAN:

OPERATING & MAINTENANCE DATA REVIEW CHECKLIST

Form 01 78 23-C

FOR IRS USE ONLY

REQUIRED DATA			Item Complete	Item Incomplete	Comment No.	Applicable Page(s)
GENERAL FORMAT						
O&M Format	Paper Quality	*01 78 23-1.2.A.2*	☐	☐		
	Typed/Printed Originals	*01 78 23-1.2.A.3*	☐	☐		
	D-Ring Binder/Triple Post	*01 78 23-1.2.A.4*	☐	☐		
	Binder Identification	*01 78 23-1.2.A.5*	☐	☐		
	Index Tabs - Hard & Soft PDF/CD Indexed & OCR	*01 78 23-1.2.A.6*	☐	☐		
	Dividers	*01 78 23-1.2.A.7*	☐	☐		

Document Manager **Date**

OPERATING AND MAINTENANCE BINDER SPINE INSTRUCTIONS

1. Select spine width.
2. Update form in indicated fields.
3. Insert logo.
4. Print current page.
5. Use crop marks as cutting guide.
6. Insert spine in binder.

1" BINDER SPINE

PROJECT WS No.

WS No 1

SPEC No.

Spec No 1

WTP / WWTP Facility Name 1

Prod / Equip Title 1

Project Name 1

OPERATING AND MAINTENANCE MANUAL

Volume 1

PRINT

RESET

1.5"
BINDER
SPINE

PRINT

RESET

OPERATING AND
MAINTENANCE
MANUAL

WTP/WWTP Facility Name 1.5

Prod/Equip Title 1.5

Project Name (Do Not Repeat Facility Name) 1.5

PROJECT WS No.

Project No 1.5

SPEC No.

Spec No. 1.5

Volume 1.5

2"
BINDER
SPINE

PRINT

RESET

OPERATING AND
MAINTENANCE
MANUAL

WTP/WWTP Facility Name 2

Prod/Equip Title 2

Project Name (Do Not Repeat Facility Name) 2

PROJECT WS No.

WS/Project No 2

SPEC No.

Spec No 2

Volume 2

3"
BINDER
SPINE

PRINT

RESET

OPERATING AND MAINTENANCE MANUAL

WTP/WWTP Facility Name 3

Prod/Equip Title 3

Project Name (Do Not Repeat Facility Name) 3

Project WS No.
WS/Project No 3

Spec No.
Spec Number 3

Volume (if applicable) 3

City of Phoenix, Water Services Department

Enter WTP/WWTP Facility Name **Enter WS Project No.**

Enter Project Name (DO NOT Repeat Facility Name)

Enter Contract# if App. or N/A **Enter JOA#**

City "Approval" Stamp

OPERATING AND MAINTENANCE MANUAL

Enter O&M Product/Equipment Title

Enter Spec Section No.

Enter Volume # of # (blank if none)

PRINT

RESET

Contractor

Contractor Company Name

Contractor Street Address

Contractor City, ST, Zip

Contractor Phone/Fax Number

Contractor Web Address

Engineer

Engineer Company Name

Engineer Street Address

Engineer City, ST, Zip

Engineer Phone/Fax Number

Engineer Web Address

Manufacturer

Manufacturer Company Name

Manufacturer Street Address

Manufacturer City, ST, Zip

Manufacturer Phone/Fax Number

Manufacturer Web Address

Installer

Installer Company Name

Installer Street Address

Installer City, ST, Zip

Installer Phone/Fax Number

Installer Web Address

OPERATING AND MAINTENANCE MANUAL

Prod / Equip Title

PROJECT WS No.
Enter Project N

SPEC No.
Spec No.

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WTP / WWTP Facility Name

Project Name

RESET

RESET

PRINT

OPERATING AND MAINTENANCE MANUAL

Prod / Equip Title 1

PROJECT WS No.
Project No.

SPEC No.
Spec No.

Vol if app

WTP / WWTP Facility Name

Project Name

SECTION 01 78 23.19

PREVENTIVE MAINTENANCE DATA

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Preventive Maintenance Data for new assets for use by the OWNER'S personnel:
   1. To ensure assets reach their maximum potential life
   2. To meet asset warranty condition
   3. To perform preventive maintenance as recommended by the asset manufacturer

B. The asset commissioning process shall not commence until the asset's preventive maintenance information has been documented in the City's Computer Maintenance Management System (CMMS) by the City's Water Asset Management (WAM) Team and City's operation and maintenance staff have been trained on the preventive maintenance procedures as described in 01821 - Instruction of Operations and Maintenance Personnel.

C. To ensure that the project commissioning will not be delayed and to allow the CITY adequate time to load all project data into the CMMS, the CONTRACTOR shall submit all required preventive maintenance data to the ENGINEER and the CITY with the respective shop drawing package for each asset.

D. Clarification:
   1. The term "preventive maintenance instructions" includes all information and instructions required to keep a product or piece of equipment properly maintained according to the manufacturer's recommendation to fulfill the equipment warranty conditions and ensure the equipment or asset reaches its maximum potential life.

   2. The maintenance tasks frequency are driven by calendar, run-time, or meter reading.

1.2 SUBMITTALS

A. All preventive maintenance information described above in paragraph 1.1.C shall be provided to the ENGINEER separate from the Operations and Maintenance Manual submittal. The CONTRACTOR shall submit the preventive maintenance information package as part of the shop drawing submittal package to the ENGINEER for review and approval. **SHOP DRAWING SUBMITTAL PACKAGE WILL NOT BE APPROVED WITHOUT ACCEPTANCE OF PREVENTIVE MAINTENANCE INFORMATION AS DESCRIBED IN THIS SPECIFICATION SECTION.**

B. All assets preventive maintenance information shall be reviewed and approved by the ENGINEER and the CITY and to be uploaded in the City's CMMS by the department's WAM Team. All information shall be submitted to the CITY electronically following the CITY's 01785A – Preventive Maintenance Data Submittal Form in Section 01 33 10 – REFERENCE FORMS, which is included at the end of this specification section as an example. The City will provide this form in MS ACCESS form to the ENGINEER. The information shall be per the asset's manufacturer's recommendation and includes the

following:

1. Preventive maintenance task name
2. Estimated hours to perform the task itself. This does not include employee preparation, equipment access, or safety log-out/tag-out procedure time.
3. Frequency of the task based on calendar days or run-hours, or metering log.
4. Number of staff required to perform the task safely according to the manufacturer's recommended procedure.
5. Written procedure for every preventive maintenance task in MS WORD file format as recommended by the manufacturer that:
    a. List the required specialty tools or equipment
    b. Include illustration or figure to aid staff's understanding of the asset maintenance
    c. Describe the procedure for performing inspection of the equipment in operation as appropriate.
    d. Describe component removal and/or installation and disassembly and/or assembly procedures.
    e. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
    f. Define recommended torque limited, mounting, calibration and/or alignment procedures and settings, as appropriate.
    g. Describe components to evaluate or inspect when performing annual inspection
    h. Provide lubricant and replacement part recommendations and limitations.
6. Identify recommended predictive maintenance tasks such as oil analysis, vibration analysis, infrared thermal scanning, etc. and their frequency, estimated task duration, and number of staff required to perform the task safely.
7. List all assets by asset IDs and description that will require preventive maintenance tasks.
8. The ENGINEER shall format the preventive maintenance information and instructions into the MS ACCESS file format, to be provided by the CITY, and arrange as indicated in the example below.

C. Preventive Maintenance Training Plan
    1. Each manufacturer shall submit a preventive maintenance lesson plan for each asset type according to Section 01 79 00 – Instruction of Operations and Maintenance Personnel.
    2. The preventive maintenance training plan for each asset type shall be submitted a minimum of 40 days prior to scheduled instruction or coordinate with the OWNER if this will conflict with construction schedule.

D. Example of Preventive Maintenance Information Form

Project Name: *"Cave Creek Water Reclamation Plant Rehabilitation"*	**City Project #** *WS85123456*
Engineer: *"Preventive Engineering*	**Contractor:** *"Preventive Maintenance Constructor"*

Company"								
Asset Type Description: *"Submersible Pumps"*		**Asset Manufacturer:** *"John Smith Pump Company"*						
Preventive Maintenance Task Description		**Class**	**Category**	**Task Duration (Hrs)**	**Est. Staff**	**Fre**	**Freq. Unit (Run-Time Hrs or Days)**	**Preventive Maintenance Procedure MS WORD File Name**
1.	*Change oil*	*Preventive*	*Lubrication*	*2*	*1*	*185*	*Days*	*"1234"*
2.	*Annual Inspection*	*Predictive*	*Condition Assessment*	*4*	*2*	*365*	*Days*	*"6789"*
3.	*Major overhaul*	*Preventive*	*Re-build*	*8*	*2*	*1500*	*Hrs*	*"xyz"*
4.	---			---	--	--	--	--

Assets IDs	**Asset Description**	**Max. Life (yrs)**	**Warranty**			**Warranty Certificate Reference No.**
			Start Date	**End Date**	**Duration (Mos)**	
12345678	*Raw Water Pumping, Pump No.2*	*10*	*09/15/2014*	*09/15/2015*	*12*	*"jklmn"*
98765432	*Finished Water Pumping, Pump No. 4*	*15*	*01/01/2014*	*01/01/2017*	*36*	*"a12345"*
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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Maintain and provide the ENGINEER with Record Documents as specified below, except where otherwise specified or modified in Division 2, Existing Conditions, through Division 48, Electrical Power Generation.

B. Definitions
   1. Contract Documents: The contract documents include the drawings, specifications, and addenda developed and furnished to the CONTRACTOR at the beginning of construction.
   2. As-Built Drawings: As-built drawings are an annotated set of drawings prepared by the CONTRACTOR. They show, in red, as-constructed changes to the original Contract Documents that have been made during the construction process. The As-Built Drawings may include supplemental drawings to provide the necessary detail, comply with project standards or where annotation would otherwise be impractical.
   3. Record Drawings: Record Drawings are prepared by the ENGINEER and reflect as-constructed changes that the CONTRACTOR annotated in the As-Built Drawings.
   4. Record Documents: The Record Documents include Record Drawings, specifications, addenda, approved shop drawings, samples, photographs, change orders, other modifications to the Contract Documents, test records, survey data, field orders, Request for Information, submittals, Warranty certificates, and all other documents pertinent to the CONTRACTOR'S Work.

C. Maintenance of Documents:
   1. Three sets of black line sets of plans, including any Addenda, of the Drawings will be furnished to CONTRACTOR by the OWNER.
   2. Maintain in CONTRACTOR'S field office in clean, dry, legible condition complete sets of the following: Drawings, Specifications, Addenda, approved Shop Drawings, Samples, Photographs, Change Orders, other modifications of Contract Documents, test records, survey data, Field Orders, and all other documents pertinent to CONTRACTOR'S Work.
   3. Provide files and racks for proper storage and easy access. File in accordance with filing format of Construction Specification Institute (CSI), unless otherwise approved by ENGINEER.
   4. Make documents available at all times for inspection by ENGINEER and OWNER.
   5. Record Documents shall not be used for any other purpose and shall not be removed from CONTRACTOR'S office without ENGINEER'S approval.
   6. Any contractually required testing provided by others shall be thoroughly documented by the CONTRACTOR and maintained with the project Record Documents. All testing results shall be maintained in their own separate log for the project; being kept current weekly and made readily available for viewing at

any time.

D. Marking System: Changes, revisions, additions and deletions, to the record set of Drawings shall be marked in Red.

E. Recording:
1. Submit as-built drawings and make a record of the locations of all work completed as part of the project. The as-builts must indicate the locations of the beginning(s) and end(s) of the construction, and all valves, fire hydrants, pipe fittings, service connections and appurtenances. They must also show locations and elevations where significant elevation changes occur or changes in direction in all pipe alignments. Their locations must be shown by stationing and dimensioning from appropriate monument lines or in their absence appropriate lot lines, property lines or easement line references.
2. Global Positioning System (GPS) Recording: For construction projects located in the Right-Of-Way, certain assets locations are required to be recorded with survey-grade GPS device such as Trimble GSA-6000 GeoXH (or equivalent) currently used by CITY staff to locate assets. The CONTRACTOR shall coordinate with the ENGINEER to identify assets requiring GPS coordinates (northing and easting) and elevation to the top of the buried asset. The following GPS coordinate set up shall be followed by the CONTRACTOR:
   a. Coordinate System: US State Plane 1983
   b. Zone: Arizona Central 0202 (Grid)
   c. Datum: NAD 1983 (2011)
   d. Elevation: NGVD 29
   e. Altitude Units: feet
   f. Coordinate Unit: International feet
   g. Coordinate order: North/East
   h. Projection: Transverse Mercator

3. The GPS coordinates shall be recorded on a spreadsheet provided by the ENGINEER. The ENGINEER will review the GPS coordinates provided by the CONTRACTOR and confirm their accuracy by navigating to the assets using the provided coordinates to ensure the accuracy tolerance is met. The confirmation process shall be performed before the assets are buried to ensure accuracy compliance. The coordinates will be submitted to the CITY at the project completion to be loaded into the CITY's asset registry system. In general, GPS coordinates are required for but not limited to:
   a. Valves for Water pipes, Reclaimed Water pipes, and sewage forcemains,
   b. Fire Hydrants
   c. Tap for Water Service Line, Reclaimed Water Service, and Lateral tap for sewer service
   d. Manholes
   e. Cleanouts

4. Label the Cover Sheet, Index and each supplemental sheets of each document "PROJECT RECORD" in 2-inch high printed letters.
5. Keep the As-Built Drawings current. CONTRACTOR'S refusal, failure or neglect to maintain current As-Built Drawings shall constitute sufficient basis for the ENGINEER to recommend the withholding of some or all of any payment due.

6. Do not permanently conceal any Work until required information has been recorded.
7. Drawings: Legibly mark to record actual construction including:
    a. Depths of various elements of foundation in relation to datum.
    b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
    c. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
    d. Field changes of dimensions and details.
    e. Changes made by Change Order or Field Order.
    f. Details not on original Drawings.
8. Specifications and Addenda: Legibly mark up each Section to record:
    a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
    b. Changes made by Change Order or Field Order.
    c. Other matters not originally specified.

F. Record Drawings:
1. As-Built Drawings shall be prepared for all the Work included in the Contract. On a weekly basis, furnish to the ENGINEER a full size annotated copy of the As-Built Drawings that include changes from the previous week's As-Built Drawing submittal. Annotations shall include redlined "clouds" of only those changes from the previous week's submittal. The redlined As-Built Drawings shall show the actual in-place installation of the items installed under this Contract. The redlined As-Built Drawings shall show the Work in plan and sections as required for clarity with reference dimensions and elevations that will be used to develop complete Record Drawings.
2. Develop and furnish to the ENGINEER, redlined Instrumentation and Control and Electrical Drawings showing one line diagrams with all conduit and wire sizes shown of the distribution systems and the actual in-place grounding system, lighting arrangement, motor control centers, corrected wiring diagrams, equipment and conduit and cable plans.
    a. The Contract Drawings may be used as a starting point in developing these Instrumentation and Control and Electrical As-Built Drawings. Subcontractor and manufacturer drawings may be included in this drawing package. The drawing package must be fully integrated and include the necessary cross references between drawings. The drawing package shall include interconnection and termination details to equipment furnished under this Contract.
    b. All As-Built Drawings must be submitted on a weekly basis for approval of the ENGINEER. This shall include the following composite drawings for the system being furnished:
        1) Schematic (Elementary) Diagrams: This shall include, but not be limited to, complete schematics including items furnished by others for the following:
            a) Motor Control Circuits for Starters furnished under this Contract.
            b) HVAC Control Panels furnished under this Contract.
        2) Wiring (Connection) Diagrams: These shall be included for all pre-wired equipment furnished under this Contract.
        3) Interconnection Diagrams: These shall include all interconnections to be furnished under this Contract.

4) Conduit and Cable Schedules: These shall include all conduit and cable furnished under this Contract.
5) Dimension of Outline Drawings: These shall include all equipment furnished under this Contract.
6) Power and Lighting Layout Drawings: These shall include all conduits and wiring furnished under this Contract.

3. In addition to the redlined As-Built Drawings, prepare and submit CAD ".dwg" files, version 2017 or later, for all supplemental drawings used to complete the As-Built Drawings.
4. Survey results shall be posted to the as-builts on a weekly basis.

G. Submittals:
1. Acceptance of CONTRACTOR'S monthly application for payment shall be dependent on the ENGINEER'S acceptance and agreement that CONTRACTOR'S As-Built Drawings and weekly submittals are complete, thorough and acceptable in showing all Work up through and including such work as CONTRACTOR is claiming for completion and payment on CONTRACTOR'S application for payment. Any items which do not appear on the As-Built Drawings in complete and acceptable form shall not be paid for in CONTRACTOR'S monthly payment.
2. Examination by the ENGINEER of CONTRACTOR'S As-Built Drawings will be made on a weekly basis to determine completion for consideration of monthly pay application. Also, make available all As-Built Drawings at all times to the ENGINEER for examination.
3. Prior to Completion of the Work, deliver final As-Built Drawings to ENGINEER. Substantial completion will not be made until satisfactory final As-Built Drawings are received by ENGINEER.
4. Accompany final and weekly submittals with transmittal letter containing:
   a. Date.
   b. Project title and number.
   c. CONTRACTOR'S name and address.
   d. Title and number of each As-Built Drawings.
   e. Certification that each document as submitted is complete and accurate.
   f. Signature of CONTRACTOR, or his authorized representative.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 43

SPARE PARTS AND MAINTENANCE MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Submit a complete list of all spare parts required for the project for review and comments to the ENGINEER and OWNER by no later than 50 percent of the project construction completion. The list shall include details such as equipment identification, part description, manufacture, and manufacturer part number, location in system, local vendor, storage requirements, storage location, and approximate cost. This completed list will be used to inventory all parts at time of turn over to the OWNER.

B. Spare parts and materials required to be supplied in the Contract Documents shall be furnished in manufacturer's unopened cartons, boxes, crates or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten years.

C. During construction, store parts in buildings or trailers with floor, roof and closed sides and in accordance with manufacturers' recommendations. Protect from weather, condensation and humidity.

D. Parts and materials shall be delivered to the OWNER upon Substantial Completion of the Work or during the commissioning period of the system. Until that occurs, place spare parts in permanent storage rooms or areas approved by the OWNER. The turnover procedures shall be developed by the ENGINEER.

E. Provide a letter of transmittal along with the Spare Parts Receiver Form 01 78 43-A in Specification 01 33 10– Reference Forms.

F. Full responsibility for loss or damage to parts and materials until they are transmitted to the OWNER, belongs to CONTRACTOR.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 79 00

INSTRUCTION OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide the services of factory-trained maintenance specialists to instruct OWNER'S operating and maintenance personnel in the recommended operation and the preventive maintenance procedures for equipment specified in the equipment Sections.

B. The qualifications of specialists shall be subject to approval by ENGINEER.

C. The scheduling of these services shall be coordinated with the OWNER and ENGINEER, with a minimum of 14 days prior notice.

D. Manufacturer shall provide a combination of classroom and field training. All training shall be conducted at the OWNER's Facility, unless otherwise stated in the equipment Sections. Class size shall be limited to no more than 15 trainees. Manufacturer shall provide training for all work shifts, or as approved by OWNER.

E. Manufacturer shall allow any and all training sessions to be digitally recorded by OWNER.

F. Section 11 00 00, General Equipment Provisions, Section 01 73 19, Installation of Equipment, Section 01 75 00, Starting and Placing Equipment in Operation, and Section 01 75 16, Equipment and System Startup and Performance Testing, includes, additional requirements for manufacturer's and supplier's field and test data.

G. Instruction of OWNER'S personnel shall commence only after the equipment has been started, approved preventive maintenance information has been turned over to the OWNER, and acceptance tests have been completed according to the provisions in Section 01 75 00, Startup and Adjusting in Operation, and Section 01 75 16, Startup Procedures.

H. Submit a copy of this Section 01 79 00, Instruction of Operations and Maintenance Personnel, to all manufacturers of equipment for this contract.

1.2 SUBMITTALS

A. Manufacturer shall submit for approval the following:
   1. Proposed Operation Lesson Plan for each scheduled instruction 14 days prior to commencement of training. Lesson plans shall be approved a minimum of 7 days prior to scheduled instruction.
   2. Proposed Manufacturer's Recommended Preventive Maintenance Training Plan for each asset type a minimum of 40 days prior to scheduled instruction or

coordinate with the OWNER if this will conflict with construction schedule.

3. Credentials of their designated operating and maintenance instructor shall include a brief resume and specific details of the instructor's experience pertaining to; operation of, maintenance of, and training for the equipment specified.
4. Training Request Form: Submit the Training Request Form to the ENGINEER 14 days prior to the requested training date. Form is located in Section 01 33 10– Reference Forms, form number 01 79 00-B.
5. There shall be separate "Operating" and "Maintenance" staff training if requested by the OWNER.

1.3 INSTRUCTION LESSON PLAN

A. Manufacturer's proposed Lesson Plan shall include the elements presented in the outline of Instruction Lesson Plan in Paragraph 1.3.D., below, of this Section. Specific components and procedures shall be identified in the proposed Lesson Plan.

B. Manufacturer's proposed Lesson Plan shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed Lesson Plan. "Hands-On" demonstrations planned for the instruction shall be described in the Lesson Plan.

C. The manufacturer shall indicate the estimated duration of each segment of the training Lesson Plan.

D. Instruction Lesson Plan shall include the following as a minimum:
   1. Equipment Operation:
      a. Describe equipment's operating (process) function.
      b. Describe equipment's fundamental operating principals and dynamics.
      c. Identify equipment's mechanical, electrical and electronic components and features.
      d. Identify all support equipment associated with the operation of subject equipment (e.g., air intake filters, valve actuators, motors).
      e. Recommend standard operating procedures to cover start-up, routine monitoring and shutdown of the equipment.
   2. Detailed Component Description:
      a. Identify and describe in detail each component's function.
      b. Where applicable, group related components into subsystems. Describe subsystem functions and their interaction with other subsystems.
      c. Identify and describe in detail equipment safeties and control interlocks.

3. Equipment Preventive Maintenance (PM):
   a. Identify all recommended PM tasks, their frequency, estimated task duration, and number of staff required to perform the task safely.
   b. Identify all recommended predictive maintenance tasks such as oil analysis, vibration analysis, infrared thermal scanning, etc. and their frequency, estimated task duration, and number of staff required to perform the task safely.
   c. PM task procedures shall include:
      1) Perform an inspection of the equipment in operation.
      2) Spot potential trouble symptoms and anticipate breakdowns.
      3) Forecast maintenance requirements (predictive maintenance).
      4) Provide lubricant and replacement part recommendations and limitations.
      5) Describe appropriate cleaning practices and recommended intervals.
      6) Identify and describe the use of special tools required for maintenance of the equipment.
      7) Describe component removal/installation and disassembly/assembly procedures.
      8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
   d. Define recommended torque, mounting, calibration and/or alignment procedures and settings, as appropriate.
   e. Describe recommended procedures to check/test equipment following a corrective repair.
   f. Perform at least two “hands-on” demonstrations of all PM procedures.
   g. All PM tasks and procedures shall be submitted to the ENGINEER for review and approval and documented in the City’s computer maintenance management system (CMMS) by the Asset Management Team as described in 01 78 23.19 – PREVENTIVE MAINTENANCE DATA.

4. Equipment Troubleshooting:
   a. Define recommended systematic troubleshooting procedures.
   b. Provide component specific troubleshooting checklists.
   c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

1.4 TRAINING AIDS

A. The manufacturer’s instructor shall incorporate training aids as appropriate to assist in the instruction. As a minimum, the training aids shall include text and figure handouts. Other appropriate training aids are:
   1. Audio-Visual Aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets).
   2. Equipment cutaways and samples (e.g., spare parts and damaged equipment).
   3. Tools (e.g., repair tools, any customized tool, measuring and calibrating instruments).

B. The manufacturer's instructor shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer's proposed Lesson Plan.

1.5 "HANDS-ON" DEMONSTRATIONS

A. The manufacturer's instructor shall present "hands-on" demonstrations of operating and maintenance of the equipment for each scheduled group. The proposed "hands-on" demonstrations should be described in the manufacturer's proposed Lesson Plan.

1.6 TRAINING SCHEDULE

A. Each manufacturer shall provide as a minimum the following hours of training. Travel time and expenses are responsibility of manufacturer and are not included in training schedule time.

Equipment	*Section*	*Training Hours*
Solid Handling Submersible Wet Well Pumps	43 25 00	8
Biofilter	44 31 21.23	8
Plug Valves	40 05 62	8
Ferrous Chloride Pumping System	46 33 11	8
HVAC Equipment	23 05 93	8
Variable Frequency Drives (VFDs)	40 97 00	8
Service Entrance Sections	26 21 00	8
Switchgear	26 23 10	8
Switchboard and Panelboards	26 24 10/26 24 16	8
Generator	26 32 13.10	8
Transfer switches	26 36 23	8
Instruments	40 70 00	4 Per instrument
PLC/HMI system	40 67 00/40 68 70	8
Pump Control Panel	40 67 00/40 68 70	8
Backup Pump Control Panel	40 67 00/40 68 70	8
Security	Division 28	8
Electric Motors Larger than 250 HP	43 28 13	8

B. The plant operators work on a shift schedule. Develop the training schedule to account for training classes for each shift.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 93 13.15

COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM TAGS

1.1 GENERAL

1.2 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals, as shown on the Drawings, specified and required to furnish and install the Computerized Maintenance Management System (CMMS) tag system.
   2. The extent of the CMMS tag system is specified herein and shown on the Drawings.
   3. The CMMS tag system includes, but is not necessarily limited to, the following:
      a. CMMS tags.
      b. Miscellaneous mechanical fasteners.

B. CMMS Tags:
   1. Provide sufficient quantity of identification tags for each piece of equipment listed in table 3.3.A. below.

1.3 QUALITY ASSURANCE

A. Source Quality Control: All CMMS tags shall be the product of a single manufacturer.

1.4 SUBMITTALS

A. Samples: Submit for approval samples for color, materials and accessories required for the CMMS tag system. ENGINEER'S review of samples will be for color, material and fastener only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Fasteners and accessory items.
   2. Samples of actual equipment identification tags for five devices.

C. CMMS Tag List: Submit for approval the following:
   1. Submit the finalized list of all CMMS tags including any alterations to the list that occur during construction. The list shall be provided on a compact disc in Microsoft Excel format (latest version) and shall include columns as shown under 3.3.A, CMMS Tag Information

PART 2 - PRODUCTS

2.1 CMMS TAG

A. Material of Construction:
   1. Material: Aluminum
   2. Thickness: 0.020 inches
   3. Coating: Black enamel
   4. Size: 2-inches wide by 2-inches high
   5. Shape: Square with rounded corners
   6. Holes: One (1) 3/16-inch hole centered on one end of the tag

B. Engraving:
   1. Text location: CMMS tags shall be engraved with text centered on the tag.
   2. Lettering: Engraved Arial font 1/8-inch high characters. Stamped CMMS tags are not acceptable.
   3. Text quantity: CMMS tags shall accommodate at minimum five (5) lines of engraved text with a minimum of twenty (20) characters per line.
   4. CMMS Tag information:
      a. See Table 3.3.A., CMMS Tag Information
         1) After CONTRACTOR receives approved submittals from the ENGINEER or OWNER. ENGINEER or OWNER will provide the Asset ID for the equipment requiring a tag.

C.

D. Fastener:
   1. Fasteners: 48-mil, stainless steel wire
   2. Fastener Clamp: Zinc double ferrule wire clamp.
   3. Alternate fasteners must be approved by ENGINEER.

E. Layout:
   1. Refer to article 3.3.B, below for an example of the CMMS tag layout.

F. Manufacturer and Model:
   1. Brady, Model 87637
   2. Seton
   3. Or equal

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and conditions under which the CMMS tags are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B.

3.2 INSTALLATION

A. Install CMMS tags and components at the locations shown on the Drawings or, if not shown, at the nearest control point of the corresponding equipment, i.e. the local control panel, near a manual actuator, on the equipment itself, at the electrical disconnect, etc. The CMMS tag shall not interfere with the normal operation of the equipment. Where the location of the CMMS tag is such that it is

not easily visible or the association between the CMMS tag and the corresponding equipment is not obvious install tags as directed by the ENGINEER.

B. For submersible or below ground equipment at a facility or plant, install the tag above grade next to motor disconnect or attach to the underside of the valve box cover with adhesive epoxy.

C. Repair or replace damaged units as directed by ENGINEER.

3.3 EQUIPMENT INFORMATION

A. CMMS Tag Information:

Service Description	Equipment Name	Serial Key	Asset ID	Initial Installed or Purchased Year
Schedule of CMMS Tag to be provided in Final Specs	Schedule of CMMS Tag to be provided in Final Specs	Schedule of CMMS Tag to be provided in Final Specs	Schedule of CMMS Tag to be provided in Final Specs	Schedule of CMMS Tag to be provided in Final Specs

B. Example CMMS Tag Layout:

+ + END OF SECTION + +

SECTION 01 99 00

COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes: Responsibility of the OWNER, ENGINEER and CONTRACTOR during the Commissioning Phase(s) of the Project.

B. Start-up and Commissioning of the Work, or a specified part of the Work, under this Project shall be as described in Section 01 32 16.15, Construction Progress Schedule and Section 01 14 16, Coordination with OWNER'S Operations. Work under this Section shall not start until the Work under Section 01 32 16.15, Construction Progress Schedule, Section 01 14 16, Coordination with OWNER'S Operations, Section 01 75 00, Starting and Placing Equipment in Operation, Section 01 75 16, Startup Procedures; Section 01 78 23, Operation and Maintenance Data, Section 01 78 39, Project Record Documents and Section 01 79 00, Instruction of Operations and Maintenance Personnel, and Special Tests as defined under the individual technical specifications, Divisions 1 through 48 has been completed; and Notice of Substantial Completion for the Work as defined in the Supplementary Conditions has been completed and issued by the ENGINEER. Spare parts shall also be on-site and accepted prior to Commissioning.

C. In addition to the testing required by this Section, the CONTRACTOR shall perform all other tests required by the detailed equipment specifications.

1.2 DEFINITIONS

A. Commissioning: The sequential process in which a newly constructed facility is put into successful operation.

B. Successful Operation: The resultant operation of all the processes and related controls in a manner that is consistent with the Contract Documents.

C. Manual Operational Mode: This operational mode represents the lowest level of control philosophy utilized in the plant instrumentation and control system. For all practical purposes, it means that an operational control decision requiring equipment or process monitoring or control will require an individual to physically go to the local control for the associated task in order to operate the facility. In the manual operational mode, the focus will be on verifying that the equipment and processes function correctly, independent of the instrumentation system and control system. The estimated duration of the manual commissioning period is 25 percent of the total Work/Work area commissioning duration.

D. Semi-Automatic Operational Mode: The highest level of control philosophy utilized in the plant instrumentation and control system.

1.3 SUBMITTALS

A. Preventive and Unscheduled Maintenance Plan: Submit detailed plan prior to start of Commissioning for providing all preventive and unscheduled maintenance of all equipment and facilities in the plant throughout the entire commissioning phase of the project.

B. OWNER'S Personnel Training Schedule and Plan: Submit detailed plan and schedule for training OWNER'S personnel in accordance with Section 01 79 00, Instruction of Operations and Maintenance Personnel.

1.4 REQUIREMENTS

A. Commissioning process will commence after issuance of the Work/Work area Notice of Substantial Completion to CONTRACTOR.

B. The commissioning process for the Project will consist of the following:

Commissioning Phases		
Work/Work Area	**Commissioning Requirements**	**Commissioning Duration (Calendar Days)**
Primary Sensors and Instruments	All instruments in manual (local) and semi automatic modes of operation	30 consecutive uninterrupted days
Pumps and associated valves	All instruments in manual (local) and semi automatic modes of operation	30 consecutive uninterrupted days
Chemical Storage and Injection Operation	All instruments in manual (local) All instruments in manual (local) and semi automatic modes of operation	30 consecutive uninterrupted days
Biofilter and Odor Control Duct Operation	All instruments in manual (local) and semi automatic modes of operation	30 consecutive uninterrupted days
Electrical Equipment	All instruments in manual (local) and semi automatic modes of operation	30 consecutive uninterrupted days
PLCs	All instruments in manual (local) and semi automatic modes of operation	30 consecutive uninterrupted days
Site Security and Lighting	All instruments in manual (local) and semi automatic modes of operation	60 consecutive uninterrupted days

C. Items required to be completed prior to the start of Commissioning include:
   1. All Vendor Operations & Maintenance Manuals.

2. All required Training.
3. All required spare parts.
4. After approval of the Specification 01 93 13.15 - Computerized Maintenance Management System Tags, CONTRACTOR shall provide and install all tags.
5. Any other items required under the contract.

D. During the course of the Commissioning Process, the ENGINEER and OWNER will evaluate design related issues and recommend design modifications which shall be implemented by CONTRACTOR through the Change Order process.

E. No system or subsystem shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

1.5 RESPONSIBILITIES

A. Responsibilities listed do not relieve CONTRACTOR from all other responsibilities and duties associated with project closeout as defined in Division 0 and Division 1, General Requirements of the Specifications.

B. CONTRACTOR'S Responsibilities during the Commission Process:
   1. Provide on call service (24 hours per day and seven days per week), which includes all staff, labor, materials, equipment and appurtenances required for carrying out CONTRACTOR'S commissioning duties described below.
   2. All Change Order work resulting from the evaluation of design-related issues by the ENGINEER and OWNER.
   3. All preventive and unscheduled maintenance of all equipment and facilities. This shall include, but not be limited to the following:
      a. Providing all lubricants.
      b. Lubrication of all equipment in accordance with Manufacturer's recommendations.
      c. Perform all Manufacturer recommended preventive maintenance, including instrument calibrations.
      d. Exercise all equipment not in use during Commissioning phase.
      e. Repair all failed equipment.
      f. Periodic check of all equipment alignment, vibration, and noise levels to ascertain conformance with Specifications.
      g. Provide all parts required for equipment repair.
      h. Provide all tools and miscellaneous equipment required for equipment repair.
      i. Administration/logging/documentation of all preventive maintenance and repair work.
      j. Cleanup associated with equipment failure and repair.
      k. Daily cleanup of buildings and site.
      l. Landscaping maintenance.
      m. Roadway cleanup and maintenance.
      n. Replacement of all HVAC filters.
   4. Warranty related issues/items.
   5. Other contractual requirements including, but not limited to, incomplete Work list.

C. OWNER'S Responsibilities during the Commissioning Process:
   1. Perform all laboratory analysis required for plant operations.
   2. Assisting ENGINEER in the evaluation of design related issues and recommendations of modifications to be implemented by CONTRACTOR through the change order process.

D. ENGINEER'S Responsibilities during Commissioning Process:
   1. Provide staff for Commissioning Phases.
   2. Assist OWNER with Operation of facilities.
   3. Provide OWNER with systems training of the Commissioning Process.
   4. Provide liaison and coordination between CONTRACTOR and OWNER'S activities.
   5. Administer Change Order work performed by CONTRACTOR.

E. Based upon the data compiled during the commissioning period modifications may be required. The ENGINEER and OWNER may issue a request for proposal to modify the Work, to change design or process related issues. A respond to these requests is expected. Appropriate cost and time adjustment will be made to address the proposed change.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 02 41 00

DEMOLITION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required for demolitions, removal and disposal Work.
   2. Included, but not limited to, are demolition and removals of existing materials, equipment, or work necessary to install the Work as shown on the Drawings, specified and required to connect same with existing work in an approved manner. Demolition includes structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical equipment, paving, curbs, walks, fencing, and similar existing facilities.
   3. Demolitions and removals which may be specified under other Sections shall conform to requirements of this Section.
   4. Pay for all landfill disposal fees.

1.2 SUBMITTALS

A. Schedule: Submit for approval proposed methods, equipment, and operating sequences. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of OWNER'S operations.

1.3 JOB CONDITIONS

A. Protection:
   1. Perform all demolition and removal Work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
   2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.
   3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices.
   4. Repair damage to facilities to remain, or to any property belonging to the OWNER or occupants of the facilities. Comply with requirements of Section 31 10 00, Site Clearing.

B. Scheduling:
   1. Carry out operations so as to avoid interference with OWNER'S operations and work in the existing facilities. Comply with requirements of 01 14 16, Coordination With OWNER'S Operations

C. Notification:
   1. At least 48 hours prior to commencement of a demolition or removal, notify ENGINEER, in writing, of proposed schedule therefore. OWNER will inspect the existing equipment and mark for identification those items which are to remain the property of the OWNER. Do not start removals without the permission of the ENGINEER.

D. Explosives:
   1. Do not bring explosives on site nor use explosives without written consent of authorities having jurisdiction. Such written consent will not relieve CONTRACTOR of total responsibility for injury or damage caused by CONTRACTOR'S blasting operations.
   2. Perform all blasting, if permitted, in compliance with applicable governing regulations.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. All materials and equipment removed from existing work, shall become the property of CONTRACTOR, except for those which OWNER has identified and marked for their use. All materials and equipment marked by the OWNER to remain the property of the OWNER shall be carefully removed by CONTRACTOR, so as not to be damaged, and shall be cleaned and stored on or adjacent to the site in a protected place specified by the ENGINEER or loaded onto trucks provided by the OWNER.

B. Dispose of all demolition materials, equipment, debris, and all other items not marked by the OWNER to remain off the site and in conformance with all existing applicable laws and regulations.

C. Surfaces of walls, floors, ceilings, or other areas which are exposed by any of the removals specified herein, and which will remain as architecturally finished surfaces shall be repaired and re-finished by CONTRACTOR with the same or matching materials as the existing adjacent surface or as may be otherwise approved by the ENGINEER.

D. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
   2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.

E. Building Demolition:
   1. Unless otherwise approved by ENGINEER, proceed with demolition from the top of the structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.
   2. Demolish concrete and masonry in small sections.
   3. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.
   4. Break up and remove foundations and slabs-on-grade, unless otherwise shown on the Drawings to remain.
   5. Locate equipment used for demolition Work, and remove demolished materials, so as to not impose excessive loads on supporting walls, floors or framing.

F. Pavement Demolition:
   1. All asphalt and concrete pavement demolition shall terminate at cut edges. All edges shall be linear and have a vertical cut face.

3.2 STRUCTURAL REMOVALS

A. Remove structures to the lines and grades shown on the Drawings, unless otherwise directed by the ENGINEER. Where no limits are shown on the Drawings, the limits shall be 4-inches outside the item to be installed. The removal of masonry beyond these limits shall be at CONTRACTOR'S expense and these excess removals shall be reconstructed to the satisfaction of the ENGINEER, with no additional compensation to CONTRACTOR.

B. All concrete, brick, tile, concrete block, roofing materials, reinforcement, structural or miscellaneous metals, plaster, wire mesh and other items contained in or upon the structure shall be removed and taken from the site, unless otherwise approved by the ENGINEER. Demolished items shall not be used in backfill.

C. After removal of parts or all of masonry walls, slabs and like work which tie into the Work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

D. The jambs, sills and heads of any windows, passageways, doors, or other openings cut into the Work or existing work, shall be dressed with new masonry, concrete or metal to provide a smooth, finished appearance.

E. Where new anchoring materials, including bolts, nuts, hangers, welds and reinforcing steel, are required to attach the Work to the existing work they shall be included under this Section, except where specified elsewhere.

3.3 MECHANICAL REMOVALS

A. Mechanical removals shall consist of dismantling and removing of existing piping, pumps, motors, equipment and other appurtenances as specified, shown, or required for the completion of the Work. Mechanical removals shall include cutting, capping, and plugging as required, except that the cutting of existing piping for the purpose of making connections thereto will be included under Mechanical Division.

B. Existing process, water, chemical, gas, fuel oil and other piping not required for the Work shall be removed where shown on the Drawings or where it will interfere with

the Work. Piping not indicated to be removed or which does not interfere with the Work shall be removed to the nearest solid support, capped and left in place. Chemical and fuel lines and tanks shall be purged and made safe prior to removal or capping. Where piping that is to be removed passes through existing walls, it shall be cut off and properly capped on each side of the wall.

C. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping shall be removed.

D. Waste and vent piping shall be removed to points shown. Pipe shall be plugged with cleanouts and plugs. Where vent stacks pass through an existing roof that is to remain, they shall be removed and the hole in the roof properly patched and made watertight.

E. Any changes to potable water piping and other plumbing and heating system work shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with Section 33 14 10, Piping Systems, and Section 33 05 05, Buried Piping Installation, and local codes. Other plumbing piping and heating piping shall be pressure tested only.

3.4 ELECTRICAL REMOVALS AND DEMOLITION

A. Electrical removals shall consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panelboards, lighting fixtures, and miscellaneous electrical equipment all as shown on the Drawings, specified, or required to perform the Work.

B. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to keep the integrity of the grounding systems.

C. Motor Control Centers and Switchgear shall be removed or modified as shown on the Drawings. Motor Control Centers and Switchgear to be removed shall be disconnected and dismantled, and all components shall be disposed of off the site. Circuit breakers and other control equipment on modified Motor Control Centers and Switchgear that will no longer be used shall be removed, unless otherwise shown on the Drawings or specified. All new openings cut into the modified Motor Control Centers and Switchgear shall be cut square and dressed smooth to the dimensions required for the installation of the new equipment.

D. Motors shall be disconnected and removed where shown on the Drawings or specified. Motors not designated by the OWNER to be salvaged shall be removed from the site. Motors or other electrical gear designated for reuse shall be stored in enclosed, heated storage.

E. Abandoned Exposed Conduit and Wire: Generally, whenever a piece or groups of equipment are removed, all associated electrical power or control wiring which are no longer required shall be removed. The wire shall be removed back to the power

source or control panel. The conduit, unless otherwise indicated, shall be removed back to the nearest junction box or point of conduit embedment. Abandoned conduits or direct-burial cable concealed in floor or ceiling slabs, or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth, approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.

F. Where shown on the Drawings or otherwise required, wiring in the underground duct or direct-burial cable system shall be removed. All such wiring shall be salvaged and stored as specified. Verify the function of all wiring before disconnecting and removing it. Ducts which are not to be reused shall be plugged where they enter buildings and made watertight.

G. Existing panelboards where shown on the Drawings shall be removed and disposed of off the site. Where shown on the Drawings or specified, they shall be replaced with new panelboards at the same or adjacent locations. All cutting and patching necessary for the removal and replacement of panelboards shall be performed.

H. Existing lighting fixtures shall be removed or relocated as shown on the Drawings. Fixtures not relocated shall be removed from the site. Relocated fixtures shall be carefully removed from their present location and reinstalled where shown on the Drawings.

I. Existing wall switches, receptacles, starters and other miscellaneous electrical equipment, shall be removed and disposed of off the site, as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired by CONTRACTOR to the satisfaction of the ENGINEER, at no additional cost to the OWNER.

3.5 ALTERATIONS AND CLOSURES

A. Alterations shall conform with the Contract Documents, and the directions and approvals of the ENGINEER.

B. Where alterations require cutting or drilling into existing floors, walls, and roofs, the holes shall be repaired in a manner approved by the ENGINEER. Repair such openings with the same or matching materials as the existing floor, wall, or roof or as otherwise approved by the ENGINEER. All repairs shall be smoothly finished, unless otherwise approved by the ENGINEER.

C. Openings in existing concrete slabs, ceilings, masonry walls, floors and partitions shall be closed and sealed as shown on the Drawings or otherwise directed by the ENGINEER. The Work shall be keyed into the existing work in a manner approved by the ENGINEER. Reinforcing steel shall be welded to the existing reinforcing. Welding shall conform to AWS D12.1, Reinforcing Steel Welding Code. In general, use the same or matching materials as the existing adjacent surface. The finished closure shall be a smooth, tight, sealed, permanent closure acceptable to the ENGINEER.

3.6 CLEAN-UP

A. Remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the Work, all materials, equipment, waste, and debris of every sort shall be removed and premises shall be left, clean, neat and orderly. Comply with requirements of Section 31 23 00, Structural Excavation and Backfill, and Section 31 10 00, Site Clearing.

+ + END OF SECTION + +

SECTION 02 70 00

DIVERSION OF WATER OR SEWAGE FLOW AND DEWATERING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This section describes the existing conditions for temporary bypassing of sewers. Temporary bypass pumping is very important for the project, including the maintenance of service to customer connections or making alternative arrangements acceptable to customers.

B. Requirements:
   1. Proved all labor, materials and supervision to temporary bypass flow around the work in accordance with the specified needs of the rehabilitation method being utilized and dewater the pipelines in preparation for cleaning and rehabilitation.
   2. Provide the design of the bypass arrangement and describe the means and methods of accomplishing the bypassing and submitted to the ENGINEER to determine conformance to project objectives.
   3. Prior to placing the bypass system into operation, successfully test the system to 1.5 times the maximum operating pressure of the system.
   4. Notify the ENGINEER 48 hours prior to shutting down or operating the bypass. Provide continuous manned monitoring of the bypass flow.
   5. Should a spill occur, immediately contact the ENGINEER and provide immediate and proper cleanup.

C. Experience:
   1. Utilize staff and/or a subcontractor that has been directly responsible for the completion of a project that required the bypass pumping of sewage flows in excess of 5 mgd.

1.2 SUBMITTALS

1. At the Preconstruction Conference, submit drawings and complete design data showing methods and equipment proposed to be utilized in the water piping or sewer bypassing for review by the ENGINEER. Include the following information in the submittal.
   a. Drawings indicating the scheme and location of temporary water or sewer line plugs, bypass discharge lines and the method and location for discharging the bypass lines.
   b. Capacities of pumps, prime movers and standby equipment.
   c. Design calculations proving adequacy of the system and selected equipment sealed by a Professional Civil Engineer, registered in the State of Arizona.
   d. Standby Power Source

e. Staffing Plan
f. Secondary Containment Provisions
g. Spill Response Plan
h. Odor Control Plan

1.3 JOB CONDITIONS

A. Available Flow Data:
1. Available flow data for the water systems or sewers to be rehabilitated at the projects is located in Part 3, Section 3.1 of this specification. Flow data for the service laterals is not available. Determine the flow in service laterals and submit the data to the ENGINEER.

B. Protection:
1. Bypassing to the ground surface, receiving waters, storm drains or bypassing which results in soil or groundwater contamination or any potential health hazards is not permitted.

C. Scheduling:
1. The bypassing system is not allowed to be shut down between shifts, on holidays, weekends or during work stoppage without written permission from the ENGINEER. Provide an attendant, around the clock, whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required.

D. Service Lines:
1. Water or sanitary sewers to be bypassed may have service lines connected to adjacent users. The known service lines have been shown on the construction drawings. Verify the locations of these lines and any other service lines not shown on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide temporary pumps, conduits and other equipment to bypass flow around the work area. Furnish all necessary labor and supervision to set up and operate the pumping and bypass system.
1) Provide critical grade sound attenuated pumps capable of achieving an operating noise level of 70 decibels or less measured at a distance of 50 feet from the operating pump for the bypass pumping. Conduct sound measurement tests in accordance with the American National Standards S. 13-1971.
2) Provide pumps and bypass lines of adequate capacity and size to handle the required capacity.
3) Each internal combustion engine, used for any purpose on the job or related to the job, shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the project without said muffler.

B. Maintain on site, sufficient equipment and materials to ensure continuous and successful operation of the bypass system. Unless otherwise approved by ENGINEER, provide standby pumps on site for a minimum 50% redundancy of the bypass system flow except at least 100% redundant capacity must be provided if only one pump is being used to bypass flows. Provide, install in-place, make fully operational and be fueled at all times the standby pumps, equipment and piping. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, water line or sewer plugs, piping and other parts or system hardware to ensure immediate repair or modifications of any part of the system as necessary.

C. Unless otherwise approved by ENGINEER, provide and install fully operational redundant bypass line(s) so they can be placed in service in the event one of the bypass lines develops a leak. Provide 33% redundancy in the bypass piping for design flows, except at least one redundant bypass line must be provided when less that three bypass lines are provided by design. Provide and install independent valves on all lines for the bypass pump system so they can be quickly activated or removed form service if necessary.

D. Install all pumps, generators and other equipment with sufficient secondary containment to protect against gasoline, oil and hydraulic fluid spills. Provide a berm at the edge of the containment to prevent direct runoff of spills.

PART 3 - EXECUTION

3.1 ESTIMATED FLOWS

A. The estimated Peak flow at LS 40 can be as high as 22.5 MGD of which approximately 60% is flowing from the 36-icnh sewer from the south (13.5 MGD) and the remaining 40% 9 MGD can be contributed by the 42-inch sewer from the south. Use of this flow data in no way relieves responsibilities for design, construction and operation of an adequate and properly functioning bypass system. Rain events may result in significantly larger flow rates. Make own determination of bypass capacity needs. The bypass design must provide sufficient capacity to handle this increase.

C. Monitoring Flows:
   1. Monitor flows and bypass operations during the course of the project to ensure proper operation and ensure against upstream surcharges and/or spills.

D. Service Lines:
   1. Water or sewer service to customers must be maintained during the course of the work, unless other acceptable arrangements are made with the customer.
   2. The ENGINEER shall provide a public information representative to accompany the CONTRACTOR when visiting customers to discuss bypass pumping of services or making alternate arrangements with the customer to

discuss bypass pumping of services or making alternate arrangements with the customer for service outages.

a. No matter what arrangement is made, cooperate with the ENGINEER to provide the City of Phoenix documentation that all affected customers have been contacted and arrangements made for continuous service or alternate accommodations. This document must be submitted prior to start of work on the section of line affected.

E. Notifications;

1. Cooperate fully in providing the ENGINEER with advance notice and details pertaining to work schedule and individual service arrangements.

2. Notify the ENGINEER and City of Phoenix of any planned service interruptions at least two weeks prior to the event.

3. The ENGINEER or local public involvement firm retained by the ENGINEER shall perform notification of the work to the public. Notification shall be made door to door with printed handouts or door hangers. The information provided includes, at a minimum, the reason for the interruption, the time period of the interruption and a local 24 hour telephone hotline number for project information.
   a. The first notification is to be five days before interruption of service. Much grater advance notice may be required if an alternate to pumping the customer's service is proposed.
   b. The second notification is to be 24 hours prior to interruption of service.

3.2 PROTECTION

A. Water or wastewater spills, overflows and backups into customer's properties are not allowed. Bypassing to the ground surface, receiving waters, storm drains or bypassing which results in groundwater contamination or potential health hazards are not allowed.

B. Inspect the entire bypass pumping and piping system for leaks or spills on an hourly basis. Create an inspection log and enter the time of the inspections and the conditions of the piping and the name of the inspector into the log for review by the ENGINEER.

C. Provide ENGINEER a copy of an emergency spill response plan. Plan shall address notification and clean up procedures. Immediately take action to halt and clean up all spills and immediately notify ENGINEER of any/all spills.

D. Perform all work in compliance with OSHA standards and in no case will noise levels be permitted which would interfere with the work of the City or others. Noise levels shall be in accordance with City of Phoenix noise ordinance. Utilize sound attenuated bypass pumps with a maximum decibel rating of 70 db @ 50 feet.

E. Odor Control:

1. Employ methods and procedures that mitigate the generation and discharge of objectionable odors to the surface environment at all times.
2. Add ferric chloride to the wastewater flow upstream of bypass pumping operations to reduce odor. Make determination of flow characteristic for required dosing.
    a. Add the ferric chloride from a location upstream that will allow 10 to 15 minutes reaction time before the flow enters the work area. The chemical dosing shall reduce odors generated from the wastewater stream to a level acceptable to the City. If this is not accomplished by adding the ferric chloride only, an additional control may be required. Add hydrogen peroxide downstream to the flow that has been dosed with ferric chloride. The Hydrogen peroxide shall be added to allow a 5 – minute reaction time before the flow enters the work area. Any dosage combination of the two chemicals may be used to ensure continuous control of odors acceptable to the City.

3.3 DAMAGES

A. Repairs for any damage that may result from negligence, inadequate or improper installation, maintenance, insufficient and operation of bypass system, including mechanical or electrical failures are the responsibility of the CONTRACTOR.

+ + END OF SECTION + +

SECTION 03 11 00

CONCRETE FORMING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete formwork. The Work also includes:
      a. Providing openings in formwork to accommodate the Work under this and other Sections and building into the formwork all items such as sleeves, anchor bolts, inserts and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the formwork.
   2. Coordinate formwork specifications herein with the requirements for finished surfaces specified in Section 03 30 00, Cast-In-Place Concrete, and Section 03 20 00, Concrete Reinforcing.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of Section No. 505 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.
   2. Examine the substratum and the conditions under which concrete formwork is to be performed, and notify the ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

B. Mock-Ups for Concrete Finishes: Provide formwork for mock-ups as required for finish work shown and specified for the Work. Place embedded materials in mock-up. Construct forms using facing materials such as form liners, where required, to provide specified finishes and to the requirements specified in Section 03 30 00, Cast-In-Place Concrete. Obtain ENGINEER'S acceptance of each mock-up prior to the start of formwork. Do not remove mock-up(s) until directed by ENGINEER.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified. Where conflicts may

occur between the reference standards, the more restrictive provisions shall apply.

1. ACI 117, Standard Tolerances for Concrete Construction and Materials.
2. ACI 301, Standard Specifications for Structural Concrete.
3. ACI 347, Guide for Concrete Formwork.
4. ASTM C 805, Test Method for Rebound Number of Hardened Concrete.
5. US Product Standard, PS-1-83 for Construction and Industrial Plywood.

D. Allowable Tolerances:
   1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347, Chapter 3.3, except as otherwise specified.
   2. Architectural Finish Formwork: Offset at panel joints: 1/8-inch.

E. Install all formwork and accessories for all facilities in accordance with manufacturers' instructions.

1.3 SUBMITTALS

A. Samples:
   1. Plywood form material used for smooth form finish, 4-inch square minimum.

B. Shop Drawings:
   1. Submit for approval the following:
      a. Fabrication and erection drawings of architecturally finished concrete surfaces as shown or specified. Show the general construction of forms including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the finished concrete visually. ENGINEER'S review will be for general architectural applications and features only. Design of formwork for structural stability and sufficiency is CONTRACTOR'S responsibility.
      b. Taper tie installation, removal, and hole repair materials and procedures.
   2. Submit for information purposes the following:
      a. Copies of manufacturer's data and installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. On delivery to job site, place materials in area protected from weather, in accordance with manufacturers' recommendations.

B. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective waterproof covering. Provide for adequate air circulation or ventilation. Store materials in accordance with the manufacturers' recommendations.

C. Handle materials to prevent damage in accordance with the manufacturers' recommendations.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Smooth Finish Concrete:
   1. Unless otherwise shown or specified, construct formwork for smooth concrete surfaces with plywood, metal, metal-framed plywood-faced, or other panel type materials acceptable to ENGINEER, to provide continuous, straight, smooth as-cast surfaces with no wood grain or other surface texture imparted by the formwork. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown or specified. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Standard Finish Concrete:
   1. Form concrete surfaces designated to have a standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

C. Form Ties:
   1. Provide factory-fabricated, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying forms will be subject to approval of ENGINEER.
   2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5-inch from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a hole no larger than 1-inch diameter in the concrete surface.
   3. Ties for exterior walls, below grade walls, and walls subject to hydrostatic pressure shall have waterstops.
   4. All ties shall leave a uniform, circular hole when forms are removed.
   5. Provide stainless steel form ties for planned exposed tie hole locations, where shown on the Drawings. When used, tiebreak back point shall be at least 1-inch from outer concrete surface.
   6. Wire ties are not acceptable.

D. Form Coatings:
   1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. For concrete surfaces, which will be in contact with potable water, the form coating shall be a mineral oil base coating.

2.2 DESIGN OF FORMWORK

A. Design, erect, support, brace and maintain formwork so that it shall safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place construction that has attained adequate strength for

this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

B. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

C. Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

D. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long span members without intermediate supports, provide camber in formwork as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.

E. Design formwork to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.

F. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

G. Omit side forms of footings and place concrete directly against excavation only when formally requested by CONTRACTOR, in writing, and accepted by ENGINEER, in writing. When omission of forms is accepted, provide additional concrete required beyond the minimum design profiles and dimensions of the footings as detailed. No additional compensation will be made to CONTRACTOR for additional concrete required.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 FORM CONSTRUCTION

A. Construct forms complying with the requirements of ACI 347; to the exact sizes, shapes, lines and dimensions shown; as required to obtain accurate alignment, location and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and

inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be as determined by approved mock-up or sample panel, if specified.

B. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

C. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to forms to prevent loss of cement paste. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

D. Falsework:
   1. Erect falsework and support, brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
   2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.

E. Forms for Smooth Finish Concrete:
   1. Do not use metal cover plates for patching holes or defects in forms.
   2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
   3. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
   4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
   5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

F. Corner Treatment:
   1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Exposed corners shall be chamfered.
   2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for all architecturally formed concrete.

Extend terminal edges to required limit and miter chamfer strips at changes in direction.

3. Reentrant and unexposed corners may be formed either square or chamfered.

G. Joints:
   1. Comply with the requirements of Section 03 15 16, Concrete Construction Joints, of these Specifications for treatment of joints. Locate as shown and specified.

H. Openings and Built-In Work:
   1. Provide openings in concrete formwork shown or required by other Sections. Refer to Paragraph 1.1.B., above, for the requirements of coordination.
   2. Accurately place and securely support items to be built into forms.

I. Sealing Formwork:
   1. All formwork joints shall be tight fitting or otherwise sealed to prevent loss of cement paste.
   2. All formwork, which rests against concrete surfaces, shall be provided with a compressible gasket material between the concrete and edge of form to fill any irregularities and create a tight seal.

J. Cleaning and Tightening:
   1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement, as required to eliminate cement paste leaks.

3.3 FORM COATINGS

A. Coat form contact surfaces with a non-staining form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

C. For concrete surfaces that will be in contact with potable water, the form coating shall be a mineral oil base coating.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into the formwork, anchorage devices and other embedded items, shown, specified, or required by other Sections. Refer to Paragraph 1.1.B., above, for the requirements of coordination. Use necessary setting drawings, diagrams, instructions, and directions.

B. Edge Forms and Screeds Strips for Slabs:

1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.

3.5 FIELD QUALITY CONTROL

A. Before concrete placement, check the formwork, including tolerances, lines, ties, tie cones, and form coatings. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

B. During concrete placement, check formwork and related supports to ensure that forms are not displaced, and that completed Work shall be within specified tolerances.

If CONTRACTOR finds that forms are unsatisfactory in any way, either before or during placing of concrete, placement of concrete shall be postponed or stopped until the defects have been corrected and reviewed by ENGINEER.

3.6 REMOVAL OF FORMS

A. Conform to the requirements of ACI 301, Section 2 and ACI 347, Chapter 3.7, except as specified below.

		Temperature (F)				
		Over 95°F	70°F-95°F	60°F-70°F	50°F-60°F	Below 50°F
a.	Walls	1 day	1 day	2 days	3 days	Do not remove forms until site-cured test cylinder develops 75% of 28-day strength.
b.	Columns	2 days	1 day	3 days	4 days	
c.	Beam Soffits	7 days	4 days	5 days	6 days	
d.	Slabs over 5 in. thick	7 days	6 days	7 days	7 days	

1. Removal of Forms and Supports: Continue curing in accordance with Section 03 30 00, Cast-In-Place Concrete.

B. Form facing material shall remain in place a minimum of four days after concrete placement, unless otherwise approved by ENGINEER.

C. Results of suitable control tests of field-cured specimens may be used as evidence that the concrete has attained sufficient strength and that supporting forms and shoring may be removed prior to the periods indicated herein.

D. The time for removal of all forms will be subject to ENGINEER'S approval.

3.7 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable.

Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces. Form surfaces shall be subject to ENGINEER'S approval.

+ + END OF SECTION + +

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SECTION 03 15 16

CONCRETE CONSTRUCTION JOINTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install concrete joints.
   2. The types of concrete joints required include the following:
      a. Construction joints.
      b. Expansion joints.
      c. Control joints.
      d. Isolation joints.
      e. Waterstops.

B. General: All joints subject to hydrostatic pressure or in contact with soil, except non-water bearing slabs-on-grade, shall be provided with continuous waterstop.

1.2 QUALITY ASSURANCE

A. Standard Specifications Details:
   1. Conform all applicable requirements of Sections No. 505 and 729 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ACI 301, Standard Specifications for Structural Concrete.
   2. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.
   3. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
   4. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   5. ASTM D 1752, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   6. ASTM D 2240, Test Method for Rubber Property – Durometer Hardness.
   7. CRD-C572, U.S. Army Corps of Engineers Specifications for Polyvinyl- Chloride Waterstop.

C. All manufactured items shall be installed in accordance with manufacturer's instructions.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for all materials required.
   2. Layout of all construction and expansion joint locations prior to the submittal of steel reinforcement Shop Drawings. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

B. Samples: Submit for approval the following:
   1. Polyvinyl chloride waterstops for joints for each cross-section type used.
   2. Foam rubber and cork expansion joint fillers.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for joints in concrete shall be stored on platforms or in enclosures and covered to prevent contact with the ground and exposure to the weather and direct sunlight. Storage and handling requirements of the manufacturer shall also be followed.

PART 2 - PRODUCTS

2.1 WATERSTOPS

A. Polyvinyl Chloride:
   1. Material Requirements:
      a. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of these Specifications and the requirements of CRD-C572. No reclaimed or scrap material shall be used.
      b. Tensile strength of finished waterstop: 1400 psi, minimum.
      c. Ultimate elongation of finished waterstop: 280 percent, minimum.
      d. Minimum thickness shall be 3/8-inch.
      e. Waterstops shall be provided with a minimum of seven ribs equally spaced at each end on each side. The first rib shall be at the edge. Ribs shall be a minimum of 1/8-inch in height.
   2. Construction Joints: Waterstops shall be flatstrip ribbed type and 6-inches minimum in width, unless shown otherwise.
   3. Expansion Joints: Waterstops shall be centerbulb ribbed type and 9-inches minimum in width, unless shown otherwise. The centerbulb shall have a minimum outside diameter of 7/8-inch.
   4. Product and Manufacturer: Provide one of the following:
      a. W.R. Meadows, Incorporated.
      b. A.C. Horn, Incorporated.
      c. Greenstreak Plastic Products Company
      d. Water Seals, Inc.
      e. Paul Murphy Plastics Company.
      f. Or equal.

2.2 HYDROPHILIC WATERSTOP MATERIALS

A. General Material Properties

1. Hydrophilic waterstop materials shall be bentonite-free and shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast. Provide only where indicated in the Contract Documents.
2. The material shall be composed of resins and polymers which absorb water and cause an increase in volume in a completely reversible and repeatable process. The waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
3. Select materials which are recommended by the manufacturer for the type of liquid to be contained.

B. Hydrophilic Rubber Waterstop
1. The minimum cross-sectional dimensions shall be 3/16-inch by 3/4-inch.
2. Product and Manufacturer: Provide one of the following:
   a. Duroseal Gasket, by BBZ USA, Inc.
   b. Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
   c. Or equal.

C. Hydrophilic Sealant:
1. The hydrophilic sealant shall adhere firmly to concrete, metal, and PVC in dry or damp condition. When cured it shall be elastic indefinitely.
2. Product and Manufacturer: Provide one of the following:
   a. Duroseal Paste, by BBZ USA, Inc.
   b. Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
   c. SikaSwell S, by Sika Corporation.
   d. Or equal.

D. Hydrophilic Injection Resin
1. Hydrophilic injection resin shall be acrylate-ester based. The viscosity shall be less than 50 cps. The resin shall be water soluble in its uncured state, solvent free, and non-water reactive. In the cured state it shall form a solid hydrophilic flexible material which is resistant to permanent water pressure and shall not attack bitumen, joint sealants, or concrete.
2. Product and Manufacturer: Provide one of the following:
   a. Duroseal Inject 1K/2K, by BBZ USA, Inc.
   b. Sika Injection 29, by Sika Corporation.
   c. Or equal.

2.3 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D 1752, Type I (sponge rubber) or Type II (cork).

2.4 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide a water-soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following:
1. Rugasol-S, as manufactured by Sika Corporation for horizontal joints only.
2. Concrete Surface Retarder-Formula S, as manufactured by Euclid Chemical Company, for horizontal joints only.

3. Concrete Surface Retarder-Formula F, as manufactured by Euclid Chemical Company, for vertical joints only.
4. Or equal.

2.5 EPOXY BONDING AGENT

A. Provide a two-component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sikadur 32 Hi-Mod LPL, as manufactured by Sika Corporation.
2. Eucopoxy LPL, as manufactured by the Euclid Chemical Company.
3. Or equal.

2.6 EPOXY-CEMENT BONDING AGENT

A. Provide a three-component epoxy resin-cement blended formulated as a bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
2. Corr-Bond, as manufactured by the Euclid Chemical Company.
3. Or equal.

2.7 RUBBER BONDING AGENT

A. Product and Manufacturer: Provide one of the following:
1. Scotch-Grip 1300 Rubber Adhesive, as manufactured by 3M Company.
2. Or equal.

2.8 NEOPRENE BEARING PADS

A. Product and Manufacturer: Provide one of the following:
1. 65 Durometer, Sheet Neoprene No. 1200, as manufactured by Williams Products Company.
2. Or equal.

2.9 JOINT SEALANT

A. Sealant used in expansion joints and other locations where it is shown and which will be subject to being submerged by water for any period of time shall be a two part polyurethane type sealant meeting the requirements of ASTM C 920, Type M, Class 25. The sealant shall be specially formulated for continuous submerged conditions. The manufacturer's recommended primer must be used with the sealant.

B. The sealant shall meet the following requirements (measured at 73 degrees F and 50 percent RH):
1. Ultimate hardness (ASTM D 2240, Type A, Shore): 20 to 45.
2. Tensile strength (ASTM D 412): 200 psi, minimum.
3. Ultimate elongation (ASTM D 412): 400 percent, minimum.
4. Tear strength (ASTM D 624, die C): 75 pounds per inch of thickness, minimum.
5. Color: light gray.

C. Product and Manufacturer: Provide one of the following:
   1. Permapol RC-270 Reservoir Sealant, as manufactured by Products Research and Chemical Corporation.
   2. Sikaflex-2c, as manufactured by Sika Corporation.
   3. Or equal.

2.10 SEALANT ACCESSORIES

A. Backer Rod: Backer rod shall be an extruded closed-cell polyethylene foam rod. The material shall be compatible with the sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width at joints less than 3/4-inch wide and 1/4-inch larger in diameter at joints 3/4-inch and wider.

B. Bond Breaker Tape: Bond breaker shall be polyethylene or TFE-fluorocarbon self adhesive tape, as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 CONSTRUCTION JOINTS

A. Comply with the requirements of ACI 301 and as specified below.

B. Locate and install construction joints as shown on the Drawings. Additional construction joints shall be located as follows:
   1. In walls locate joints at a spacing of 40 feet maximum and approximately 12 feet from corners.
   2. In foundation slabs and slabs on grade locate joints at a spacing of approximately 40 feet. Place concrete in a strip pattern, unless otherwise indicated on the Drawings.
   3. In mats and structural slabs and beams, at a spacing of approximately 40 feet. Locate joints in compliance with ACI 301, unless otherwise indicated on the Drawings.
   4. Provide other additional construction joints as required to satisfactorily complete all Work.

C. Horizontal Joints:
   1. Roughen concrete at the interface of construction joints by abrasive blasting, hydroblasting, or the use of surface retardants and water jets to expose the aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by ENGINEER. Immediately before placing fresh concrete, thoroughly clean the existing contact surface using a stiff brush or other tools and a stream of water under pressure.

The surface shall be clean and wet, but free from pools of water at the moment the fresh concrete is placed.

2. Remove laitance, waste mortar or any other substance which may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placement or where dirt or other bond reducing contaminants are on the surface, additional light abrasive blasting or hydroblasting shall be done to remove laitance and all bond reducing materials just prior to concrete placement.
3. Place a 2-inch thick coat of mortar, one part sand and one part cement with water added to a flowable consistency or a 6-inch layer of Construction Joint Grout, as specified in Section 03 60 00, Grouting, over the contact surface of the old concrete. Place fresh concrete before the mortar or grout has attained its initial set. If the concrete mix has the slump increased to at least 6-inches by addition of a high range water reducer, the placement of mortar or grout may be omitted.

D. Vertical Joints:
1. Apply roughener to the form in a thin, even film by brush, spray or roller in accordance with the manufacturer's instructions. After roughener is dry, concrete may be placed.
2. When concrete has been placed, remove joint surface forms as early as is necessary to allow for removal of the surface retarded concrete. Forms covering member surfaces shall remain in place as required by Section 03 11 00, Concrete Forming. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER. Alternately, the surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. The outer 1-inch of each side of the joint face shall be masked and protected from the blasting to avoid damage to the member surface.

3.3 EXPANSION JOINTS

A. Comply with the requirements of ACI 301 and as specified below.

B. Locate and install expansion joints as shown. Install joint filler in accordance with manufacturer's instructions. Sealants shall be installed as specified herein.

3.4 CONTROL JOINTS

A. Control joints shall be provided in non-water bearing slabs on grade only where specifically shown. A groove, with a depth of at least 25 percent of the member thickness, shall be formed or saw-cut in the concrete. This groove shall be filled with joint sealant material as specified in Section 07 92 00, Caulking and Sealants.

B. Where the control joint is formed by sawcutting, the cut shall be made immediately after the concrete has set enough to support the saw and be cut without being damaged. The concrete shall be kept continually moist until the cutting operation.

C. Control joints may be formed with a tool or by insertion of a joint forming strip. After the concrete has gained its design strength, the upper portion of the joint forming strip shall be removed and the void filled with sealant.

3.5 ISOLATION JOINTS

A. Wherever a sidewalk or other slab on grade abuts a concrete structure and is not shown doweled into that structure, an isolation joint shall be provided. Such joint shall be formed by a 1/2-inch joint filler with the upper 1/2-inch of the joint filled with sealant.

3.6 WATERSTOPS

A. General:
   1. Comply with the requirements of ACI 301 and as specified below. All joints shall be made in accordance with manufacturer's instructions.
   2. Obtain ENGINEER'S approval for waterstop locations not shown.
   3. Provide polyvinyl chloride waterstops in all joints in concrete which are intended to retain liquid or are located below grade up to an elevation at least 12-inches above grade or to an elevation at least 12-inches above overflow liquid level in tanks, whichever is higher, except where otherwise shown or noted.

B. Polyvinyl Chloride Waterstop:
   1. Tie waterstop to reinforcement, at a maximum spacing of 18-inches, so that it is securely and rigidly supported in the proper position during concrete placement. Continuously inspect waterstops during concrete placement to ensure their proper positioning.
   2. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is required that:
      a. The material shall not be damaged by heat sealing.
      b. The splices shall have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
      c. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.
   3. Only butt type joints of the ends of two identical waterstop sections shall be allowed to be made while the material is in the forms.
   4. All joints with waterstops involving more than two ends to be jointed together, and all joints which involve an angle cut, alignment change, or the joining of two dissimilar waterstop sections shall be prefabricated by CONTRACTOR or manufacturer prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.
   5. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material, if required.
   6. The symmetrical halves of the waterstops shall be equally divided between the concrete placements at the joints and centered within the joint width, unless shown otherwise. Centerbulb waterstops shall be placed in expansion joints so that the centerbulb is centered on the joint filler material.
   7. When any waterstop is installed in the forms or is embedded in the first concrete placement and the waterstop remains exposed to the atmosphere for more than four days, suitable precautions shall be taken to shade and protect

the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

8. Waterstop placed in joints intended for future concrete placement shall be protected from direct rays of the sun by temporary means until a permanent cover is installed so that the waterstop is not exposed to the direct rays of the sun for more than a total of four days.

C. Hydrophilic Rubber Waterstop and Sealant
   1. Where a hydrophilic rubber waterstop or sealant is called for in the Contract Documents, or where approved by the ENGINEER, it shall be installed with the manufacturer's instructions and recommendations; except, as modified herein.
   2. When requested by the ENGINEER, the manufacturer shall provide technical assistance in the field.
   3. The waterstop or sealant shall be located as near as possible to the center of the joint and it shall be continuous around the entire joint. The minimum distance from the edge of the waterstop to the face of the member shall be 3-inches.
   4. Where a hydrophilic rubber waterstop is used in combination with PVC waterstop, the hydrophilic rubber waterstop shall overlap the PVC waterstop for a minimum of 6-inches. The contact surface between the hydrophilic rubber waterstop the PVC waterstop shall be filled with hydrophilic sealant.
   5. Where wet curing methods are used, hydrophilic rubber waterstop and sealant shall be applied after curing water is removed and just prior to the closing up of the forms for the concrete placement. Hydrophilic rubber waterstop and sealant shall be protected from the direct rays of the sun and from becoming wet prior to concrete placement. If the material does become wet and expands, it shall be allowed to dry until it has returned to its original cross sectional dimensions before concrete is placed.
   6. The hydrophilic rubber waterstop shall be installed in a bed of hydrophilic sealant, before skinning and curing begins, so that any irregularities in the concrete surface are completely filled and the waterstop is bonded to the sealant. After the sealant has cured, concrete nails, with washers of a diameter equal to the waterstop width, shall be placed to secure the waterstop to the concrete at a maximum spacing of 18-inches.
   7. Prior to installation of hydrophilic sealant, the concrete surface shall be wire brushed or sand blasted to remove any laitance or other materials that may interfere with the bonding. Surfaces of metal or PVC to receive sealant shall be cleaned of paint and any material that may interfere with bond. When sealant alone is shown on the Contract Documents, it shall be placed in a built up bead which has a triangular cross section with each side of the triangle at least 3/4-inch in length, unless indicated otherwise. Concrete shall not be placed until the sealant has cured as recommended by the manufacturer.

3.7 BONDING AGENT

A. Use epoxy bonding agent for bonding of fresh concrete to concrete that has been in place for at least 60 days or to existing concrete.

B. Use epoxy-cement bonding agent for the following:
   1. Bonding toppings and concrete fill to concrete that has been in place for at least 60 days or to existing concrete.

2. For all locations where bonding agent is required and concrete cannot be placed within the open time period of epoxy bonding agent.
3. Bonding of horizontal construction joints where these are required by the Drawings or approved by ENGINEER for foundation mats that are five feet thick or greater.

C. Use a cement-water slurry as a bonding agent for toppings and concrete fill to new concrete. The cement water slurry shall be worked into the surface with a stiff bristle broom and concrete shall be placed before the cement-water slurry dries.

D. Handle and store bonding agent in compliance with the manufacturer's printed instructions, including safety precautions.

E. Mix the bonding agent in complete accordance with the instructions of the manufacturer.

F. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with bonding agent not less than 1/16-inch thick. Place fresh concrete while the bonding agent is still tacky (within its open time), without removing the in-place bonding agent coat, and as directed by the manufacturer.

3.8 SEALANT INSTALLATION

A. Sealants shall be installed according to the manufacturer’s recommendations for sealant which is to be subjected to continuous submerged conditions and the following requirements. Prior to sealant installation, arrange to have a representative of the sealant manufacturer instruct the crew doing the Work as to the proper methods of surface preparation, mixing, and application of the sealant.

B. Surfaces to receive sealant shall be cleaned of all materials which could interfere with proper bonding. Concrete surfaces shall have all fins or other defects removed or repaired and shall receive a light abrasive blasting prior to priming and sealant application. All surfaces to receive sealant shall be completely dry.

C. Spaces to receive sealant shall be filled with joint filler as shown. Where not shown, the space shall be filled with joint filler or a backer rod so that the depth of sealant does not exceed the width of the space. Where the bottom of the space to receive sealant is formed by a material other than backer rod, a bond breaker tape shall be placed. The maximum sealant depth, at middle of the joint width, shall be 1/2-inch.

D. The primer and sealant used shall be supplied by the same manufacturer. No sealant shall be placed without the use of a primer.

E. Self-leveling sealants shall only be used in joints with a slope less than 0.5 percent and where maximum and minimum sealant depths can be maintained. Non-sag sealant shall be used at all other locations and may be used instead of self-leveling sealant. All non-sag sealant shall be tooled to a uniform concave surface before skinning and curing begins.

F. Sealant material shall be conditioned to be within the optimum temperature range recommended by the manufacturer for installation for a minimum of 16 hours prior to installation. Installation shall proceed only when the substrate is at a temperature

recommended by the manufacturer. Sealant shall not be placed if there is a threat of imminent rainfall. Submit a letter certifying that the applied sealants were installed in accordance with the manufacturer's recommendations, including temperature, relative humidity, etc.

G. All joints to receive sealant shall be inspected by the ENGINEER prior to sealant placement.

H. All sealant shall achieve final cure at least seven days before the structure is filled with water.

I. Any sealant which, after the manufacturer's recommended curing time for the job conditions, fails to fully and properly cure shall be completely removed. The surfaces to receive sealant shall be completely cleaned of all traces of the improperly cured sealant and primer. The specified sealant shall then be reinstalled. All costs of such removal, surface treatment, and reinstallation shall be at the expense of CONTRACTOR.

3.9 BEARING PAD INSTALLATION

A. Neoprene Bearing Pad: Install with water insensitive adhesive in accordance with manufacturer's instructions.

+ + END OF SECTION + +

SECTION 03 15 19

ANCHORAGE IN CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install anchor bolts, concrete anchors (adhesive and expansion anchors), and concrete inserts.

B. Coordination: This Section includes all bolts, anchors and inserts required for the Work but not specified under other Sections.

C. The types of work using anchor bolts and anchors drilled into concrete or masonry includes, but is not limited to, the following:
   1. Structural members and accessories.
   2. Metal, wood, and plastic fabrications.
   3. Equipment.
   4. Sluice and slide gates.
   5. Tanks.
   6. Piping.
   7. Grating and floor plate.
   8. Electrical, Plumbing and HVAC Work.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
   1. American Concrete Institute (ACI):
      a. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
   2. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. 355.2, Seismic Testing of Post-Installed Concrete and Masonry Anchors in Cracked Concrete.
      c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
   3. ASTM A 36, Specification for Structural Steel.
   4. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   7. ASTM A 484/A 484M, Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
   8. ASTM A 525, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

9. ASTM A 536, Specification for Ductile Iron Castings.
10. ASTM A 570/A 570M, Specification for Structural Steel, Sheet and Strip, Carbon, Hot-Rolled.
11. ASTM B 633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
12. ASTM F 593, Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs.
13. Federal Specification, FF-S-325 for Concrete Expansion Anchors.
14. International Code Council Evaluation Service (ICC-ES):
    a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
    b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit schedule (table or listing) of types, sizes (diameter, length, embedment length), material, finish, and proposed manufacturers of anchorages to concrete to be provided. Apportion by Project-specific application (for example, “Anchorages for cooling water pumps in basement”) and indicate where anchorages are fully designed by Engineer and those for which final design was prepared by delegated design professional.
   2. Engineer’s approval of such Shop Drawing will be only for anchorages fully designed by Engineer. For anchorages for which final design is by delegated design professional, include on such Shop Drawing delegated design professional’s approval stamp.
   3. Product Data: Submit as Action Submittals product data for anchorages to concrete fully designed by Engineer. For anchorages to concrete for which final design is by delegated design professional, submit as Informational Submittals bearing approval stamp of delegated design professional.
      a. Manufacturer’s express, written acknowledgement that proposed items comply with referenced standards indicated in this Section and, as applicable, by delegated design professional.
      b. Manufacturer published data and information for each anchor.
         1) Clearly indicate items that are proposed for the Work. Neatly strike out or obscure materials and products not proposed.
      c. Manufacturer's published installation instructions and instructions for code-required special inspections and tests.
      d. Post-Installed Anchors: In addition, submit for each post-installed anchor system current ICC-ES report, indicating the following:
         1) Manufacturer’s certification that anchors comply with requirements indicated in the Contract Documents.
         2) Performance data indicating that anchor is approved by its manufacturer for use in cracked concrete.
         3) Seismic design categories for which anchor system is approved by ICC-ES report.
      e. Anchorage layout drawings and details:
         1) Drawings showing location, configuration, spacing and edge distance.

B. Samples: Submit for approval the following:
   1. Representative samples of bolts, anchors and inserts as may be requested by ENGINEER. Review will be for type and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, concrete anchor, or concrete insert is not shown on the Drawings, provide the following:
   1. For anchor bolts (cast-in-place), provide the size, length and capacity required to carry the design load based on the values and requirements given in the Phoenix Building Code.
   2. For concrete anchors (adhesive types) and concrete inserts, provide the size, length, type, and capacity required to carry the design load based on the values and requirements given in the ICC ES report, for the anchor to be used. Alternately the capacity may be based on independent testing lab capacities for tension and shear strength using a minimum safety factor of four. Consideration of reduced capacity due to spacing and edge distance shall be made.

B. Determine design loads as follows:
   1. For equipment anchors, use the design load recommended by the equipment manufacturer and approved by ENGINEER.
   2. For pipe hangers and supports, use one half of the total weight of: pipe, fittings, and water contained in pipe, plus the full weight of valves and accessories located between the hanger or support in question.
   3. Allowances for vibration are included in the safety factor specified above.
   4. Concrete anchors shall develop ultimate shear and pull-out loads of not less than the following values in 4000 psi concrete:

Bolt diameter Inches)	Min Shear (Pounds)	Min Pull-Out Load (Pounds)
1/2	5,000	7,600
5/8	8,000	12,000
3/4	11,500	17,000
7/8	15,700	20,400
1	20,500	28,400

2.2 APPLICATION

A. Where a concrete anchor is shown on the Drawings, either an adhesive anchor or anchor bolt shall be used. In masonry, where a concrete anchor is indicated, only anchor bolts and adhesive anchors shall be used.

B. Anchor Bolts (cast-in-place)
   1. Shall be used where indicated and may be used where concrete anchors are indicated.

2. Where an anchor bolt is indicated, only a cast-in-place anchor bolt shall be used, unless another anchor type is accepted by the ENGINEER.
3. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.

C. Adhesive Anchors:
1. Use wherever concrete anchors are shown on the Drawings.
2. Use where subject to vibration or where buried or submerged.
3. Use for pipe supports.
4. Use in concrete and masonry.
5. Shall not be used in ceilings.
6. Shall not be used for pipe hangers.

D. Concrete Inserts:
1. Use only where indicated.
2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

2.3 MATERIALS

A. Anchor Bolts:
1. Provide carbon steel bolts complying with ASTM A 307, headed or non-headed type, unless otherwise indicated.
2. Provide stainless steel bolts complying with ASTM F 593, AISI Type 316 headed or non-headed type with nitronic 60 stainless steel nuts and locknuts, unless otherwise indicated.
3. In buried or submerged locations, provide stainless steel bolts complete with washers complying with ASTM F 593, AISI Type 316 and with nitronic 60 stainless steel nuts and locknuts. Other AISI types may be used subject to ENGINEER'S approval.
4. For equipment, provide anchor bolts, which meet the equipment manufacturer's recommendations for size, material, and strength.
5. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.
6. Locate and accurately set the anchor bolts using templates or other devices as required.
7. Protect threads and shank from damage during installation of equipment and structural steel.
8. Comply with manufacturer's required embedment length and necessary anchor bolt projection.

B. Adhesive Anchors:
1. Provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
2. In buried or submerged locations, provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
3. Anchors shall be of the size required for the concrete strength specified.

4. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt, unless noted otherwise on the Drawings.
5. Product and Manufacturer: Provide one of the following:
   a. Hilti:
      1) HIT RE 500 V3 (ICC ESR-3814).
      2) HIT-HY 200 V3 (ICC-ES ESR-4868).
   b. Dewalt:
      1) PURE110+ (ICC-ES ESR-3298).
      2) AC100+ Gold (ICC-ES ESR-2582).
      3) AC200+ (ICC-ES ESR-4027).
   c. Simpson Strong-Tie:
      1) SET-3G (ICC ES 4057)
   d. Or equal.

C. Concrete Inserts:
   1. For piping, grating, floor plate and masonry lintels, provide malleable iron inserts. Comply with Federal Specification WW-H-171E (Type 18). Provide those recommended by the manufacturer for the required loading.
   2. Finish shall be black.
   3. Product and Manufacturer: Provide one of the following:
      a. Figure 282, as manufactured by ITT Grinnell.
      b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
      c. Or equal.

D. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by ENGINEER.

E. Expansion anchors will not be allowed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which anchor bolts, expansion anchors and concrete insert Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Assure that embedded items are protected from damage and are not filled in with concrete.

B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

C. For the adhesive anchors and adhesive material, comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar. Properly clean out the hole utilizing a non-metallic fiber bristle brush and compressed air to remove all loose material from the hole, prior to installing adhesive material. Install adhesive anchors in concrete aged not less than 21 days.

D. Adhesive anchor manufacturer's representative shall observe and demonstrate the proper installation procedures for the adhesive anchors and adhesive material at no additional expense to OWNER. Each installer shall be certified in writing by the manufacturer to be qualified to install the adhesive anchors.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Employ a testing laboratory to perform field quality testing of installed anchors. Field engineer is to determine the level of testing which is required for the various types of adhesive anchors and anchor bolts. A minimum of ten percent of the adhesive anchors and reinforcing bars are to be tested to 50 percent of the ultimate tensile capacity of the adhesive anchor or reinforcing bar.

B. If failure of any of the adhesive anchors or reinforcing bars occurs, testing the remaining 90 percent will be required and the costs involved belong to the CONTRACTOR. Responsibility belongs to CONTRACTOR to correct improper workmanship, remove and replace, or correct as directed by the ENGINEER, all adhesive anchors or bars found unacceptable or deficient, at no additional cost to the OWNER.

C. The independent testing and inspection agency shall complete a report on each area of the Work where concrete anchors are installed. The report shall summarize the observations made by the inspector and be submitted to ENGINEER.

D. Provide access for the testing agency to places where work is being produced so that required inspection and testing can be accomplished.

+ + END OF SECTION + +

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SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete reinforcement.
   2. The extent of concrete reinforcement is shown.
   3. The Work includes fabrication and placement of reinforcement including bars, ties, and supports, encasements and fireproofing.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   2. ASTM A706, Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
   3. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   4. ACI 318, Building Code Requirements for Structural Concrete.
   5. ACI SP66, Detailing Manual.
   6. CRSI 1MSP, Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.

B. Allowable Placing Tolerances: Comply with ACI 318, Chapter 25 - Reinforcement Details except as specified below:
   1. Concrete surfaces which are in contact with liquids: 2-inches minimum coverage.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for all materials and reinforcement accessories. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
   2. Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Parts A and B. For walls, show elevations to a minimum scale of 1/4-inch to one foot. For slabs, show top and bottom reinforcing on separate plan views. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements, and assemblies, as required for the fabrication and placement of concrete reinforcement unless otherwise noted. Splices shall be

kept to a minimum. Splices in regions of maximum tension stresses shall be avoided whenever possible.

3. Drawings detailing the location of all construction and expansion joints as required under Section 03 15 16, Concrete Construction Joints, shall be submitted and approved before Shop Drawings for reinforcing steel are submitted.

B. Certificates:
   1. Submit one copy of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

1.4 DELIVERY, HANDLING AND STORAGE

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground. Comply with the requirements of 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: ASTM A 615, and as follows:
   1. Provide Grade 60 for all bars, unless indicated otherwise.

B. Mechanical Couplers: Reinforcement bars may be spliced with a mechanical connection. This connection shall be a full mechanical connection which shall develop in tension or compression, as required, at least 125 percent of specified yield strength (fy) of the bar in accordance with ACI 318.

C. Steel Wire: ASTM A 1064.

D. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcement in place.
   1. Use wire bar type supports complying with CRSI "Manual of Standard Practice" recommendations, except as specified below. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks, 4-inch square in plan, with embedded tie wire as specified by CRSI, "Manual of Standard Practice". The precast concrete blocks shall have the same or higher compressive strength as specified for the concrete in which they are located.
   3. For all concrete surfaces, where legs of supports are in contact with forms, provide supports complying with CRSI "Manual of Standard Practice" as follows:

a. At formed surfaces in contact with soil, weather, or liquid or located above liquid, supports shall be all plastic construction meeting the requirements of CRSI Manual of Standard Practice.
   1) 100% non-metallic, non-corrosive.
b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.
c. At formed surfaces with an architectural finish, use stainless steel protected legs (Type B).

4. Over waterproof membranes, use precast concrete chairs.

E. Drilled Dowels
1. Adhesive material for drilled dowels shall be a vinylester resin, epoxy resin, urethane methacrylate, or vinyl urethane resin. Polyester resin shall not be used. The resin shall be a high modulus, moisture insensitive type. The resin shall be packaged in a cartridge type dispensing system with a mixing nozzle. The resin shall be formulated to maintain its bond and integrity under continuous submergence by water. The adhesive anchoring systems shall have an ultimate capacity in excess of 125 percent of the yield strength of the reinforcing steel at an embedment of 12 bar diameters.
2. Adhesive systems shall be as specified in Section 03 15 19.

2.2 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI, “Manual of Standard Practice”. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.

B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the Work:
1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
2. Bends or kinks not shown on approved Shop Drawings.
3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Comply with the applicable recommendations of specified codes and standards, and CRSI, “Manual of Standard Practice”, for details and methods of reinforcement placement and supports.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
   1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Prior to placement of concrete, demonstrate to ENGINEER that the specified cover of reinforcement has been attained, by using a surveying level or string line.
   3. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcing bars more than 2-inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

E. Lap Splices:
   1. Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

F. Mechanical Couplers:
   1. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

G. Drilled Dowels
   1. Drilled dowels shall be reinforcing dowels set in a resin adhesive in a hole drilled into hardened concrete.
   2. Holes shall be drilled to the adhesive anchor system manufacturer's recommended diameter and depth to develop the required pullout resistance but shall not be greater in diameter than 1/4-inch more than the nominal bar diameter nor less than 12 times the nominal bar diameter in depth.
   3. The hole shall be drilled by methods which do not interfere with the proper bonding of the resin. Only masonry type drill bits shall be used.
   4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes to be drilled shall be adjusted to avoid drilling

through or nicking any existing reinforcing bars only after approval by the ENGINEER.

5. The hole shall be brushed (non-metallic bristle brush only) and blown clean with clean, dry compressed air to remove all dust and loose particles.
6. Resin shall be injected into the hole through the injection system-mixing nozzle (and any necessary extension tubes) placed to the bottom of the hole. The discharge end shall be withdrawn as resin is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that ensures that excess material is expelled from the hole during dowel placement.
7. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with resin. The bar shall be inserted slowly enough to avoid developing air pockets.

3.3 INSPECTION OF REINFORCEMENT

A. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected.

B. Formwork for walls and other vertical members will not be closed up until the reinforcing steel is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected.

C. Testing of Drilled Dowels: Employ a testing agency to perform field quality control testing of the drilled dowel installation. After completion of the manufacturer's recommended curing period and prior to placement of connecting reinforcing, ten percent of drilled dowels installed shall be proof tested for pullout. The drilled dowels shall be tensioned to 60 percent of the specified yield strength. Where dowels are located less than six bar diameters from the edge of concrete, the ENGINEER will determine the tensile load required for the test. If any dowels fail, all installed dowels shall be tested. Dowels that fail shall be reinstalled and retested at CONTRACTOR'S expense.

+ + END OF SECTION + +

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install cast-in-place concrete.
   2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured. The Work also includes:
      a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchor bolts, inserts and all other items to be embedded.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

C. Classifications of Concrete:
   1. Type "1" concrete shall be steel reinforced and includes the following:
      a. All concrete, unless indicated otherwise.
   2. Type "2" concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following:
      a. Concrete fill within structures.
      b. Unreinforced encasements.
      c. Curbs and gutters.
      d. Sidewalks.
   3. Type "4" concrete shall be unreinforced and used where required as concrete fill under foundations, filling abandoned piping and wherever “lean” concrete is required on the Drawings.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of Section Nos. 505, 725 and 726 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete.

2. ACI 301, Specifications for Structural Concrete (includes ASTM Standards referred to herein).
3. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305, Hot Weather Concreting.
5. ACI 306, Cold Weather Concreting.
6. ACI 309, Guide for Consolidation of Concrete.
7. ACI 311, Guide for Concrete Inspection.
8. ACI 318, Building Code Requirements for Structural Concrete.
9. ANSI/NSF 61, Drinking Water System Components-Health Effects.
10. AASHTO M 182, Burlap Cloth Made From Jute or Kenaf.
11. AASHTO TP 23, Proposed Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
12. ASTM C 31, Practice for Making and Curing Concrete Test Specimens in the Field.
13. ASTM C 33, Specification for Concrete Aggregates.
14. ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
15. ASTM C 42, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
16. ASTM C 94, Specification for Ready-Mixed Concrete.
17. ASTM C109, Test Method for Compressive Strength of Hydraulic Cement Mortars.
18. ASTM C 143, Test Method for Slump of Hydraulic- Cement Concrete.
19. ASTM C 150, Specification for Portland Cement.
20. ASTM C 157, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
21. ASTM C 171, Specification for Sheet Materials for Curing Concrete.
22. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.
23. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
24. ASTM C 260, Specification for Air-Entraining Admixtures for Concrete.
25. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
26. ASTM C 494, Specification for Chemical Admixtures for Concrete.
27. ASTM C 618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
28. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
29. ASTM C 1240, Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
30. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used for Construction.

C. Concrete Testing Service:
   1. Employ, at own expense, testing laboratories experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. The same laboratory shall not be employed to both design concrete mixes and provide field testing.
      a. Testing agency shall meet the requirements of ASTM E 329.
      b. Selection of a testing laboratory is subject to ENGINEER'S approval.

c. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information that may be requested by ENGINEER.

2. Materials and installed Work may require testing and retesting, as directed by ENGINEER, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at OWNER'S expense, including the retesting of rejected materials and installed Work, shall be done at CONTRACTOR'S expense.

D. Qualifications of Water-Reducing Admixture Manufacturer:
1. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Furnish copy of manufacturer's quality assurance handbook to document the existence of the program. Manufacturer shall maintain a concrete testing laboratory that has been approved by the Cement and Concrete Reference Laboratory at the Bureau of Standards, Washington, D.C.
2. Provide a qualified concrete technician employed by the admixture manufacturer to assist in proportioning the concrete for optimum use of the admixture. The concrete technician shall advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing jobsite conditions.

E. Laboratory Trial Batch:
1. Each concrete mix design specified shall be verified by a laboratory trial batch, unless indicated otherwise.
2. Each trial batch shall include the following testing:
a. Aggregate gradation for fine and coarse aggregates.
b. Fly ash testing to verify meeting specified properties, unless the fly ash supplier provides certification by an independent testing laboratory.
c. Slump.
d. Air content.
e. Compressive strength based on three cylinders each tested at seven days and at 28 days.
f. Shrinkage test as specified herein for Type "1" concrete mix designs.
3. Each trial batch shall provide the following information:
a. Project identification name and number.
b. Date of report.
c. Complete identification of aggregate source of supply.
d. Tests of aggregates for compliance with specified requirements.
e. Scale weight of each aggregate.
f. Absorbed water in each aggregate.
g. Brand, type and composition of cement.
h. Brand, type and amount of each admixture.
i. Amounts of water used in trial mixes.
j. Proportions of each material per cubic yard.
k. Gross weight and yield per cubic yard of trial mixtures.
l. Measured slump.
m. Measured air content.
n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.

o. Shrinkage test results where required and as specified herein.

4. The requirement for a trial batch may be waived if the required test information has been provided in a previous laboratory trial batch run on the identical mix design within the previous two years. The same brand, type, and source of all materials must have been used.

F. Shrinkage Test:
1. Drying shrinkage tests will be made for the trial batch as specified herein.
2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10-inches, fabricated, cured, dried and measured in accordance with the requirements of ASTM C 157 modified as follows: specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70°F ±3°F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73°F ±3°F. Measurement to determine expansion expressed as a percentage of original length shall be made at age seven days. This length at age seven days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73°F ±3°F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after seven days of moist curing.
3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Part 2, herein.

G. Certification of Concrete Mix:
1. The need for a trial batch may be waived if the following requirements are met. The compressive strength of each specified mix shall be verified by data from a series of a minimum of 30 consecutive tests that have been made within the previous 12 months. A test is defined as the average strength of all specimens of the same age fabricated from a sample taken from a single batch of concrete. All tests shall have been made on concrete which is identical in mix design to the submitted proposed mix design, including sources of aggregate and manufacturers of cementitious materials and admixtures. The tests must average above the specified strength with no individual test falling more than 500 psi below specified strength and no three consecutive tests averaging below specified strength. In addition, the standard deviation for the series of tests shall not exceed 640 psi as defined by ACI 214.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
   2. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.
   3. The following information, if ready-mixed concrete is used.
      a. Physical capacity of mixing plant.
      b. Trucking facilities available.
      c. Estimated average amount that can be produced and delivered to the site during a normal eight-hour day, excluding the output to other customers.

B. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. ENGINEER'S review will be for general information only. Production of concrete to comply with specified requirements is the responsibility of CONTRACTOR.

C. Submit notarized certification of conformance to referenced standards when requested by ENGINEER.

D. Delivery Tickets: Furnish to ENGINEER copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94, Section 16.1.
   1. Provide batch tickets for each batch of job-site mixed concrete, as specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to ensure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

1.5 CONCRETE COORDINATION MEETING

A. A Concrete Coordination Meeting shall be held to review the detailed requirements of CONTRACTOR'S proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 14 days after the Notice to Proceed.

B. All parties involved in the concrete Work shall attend the conference, including but not limited to the following:
   1. CONTRACTOR'S representative.
   2. Testing laboratory representative.
   3. Concrete subcontractor.
   4. Reinforcing steel subcontractor and detailer.
   5. Concrete supplier.
   6. Admixture manufacturer's representative.

7. ENGINEER.

C. The Concrete Coordination Meeting shall be held at a mutually agreed upon time and place. The ENGINEER shall be notified no less than five days prior to the date of the Concrete Coordination Meeting.

PART 2 - PRODUCTS

2.1 GENERAL

A. All admixtures, curing compounds, etc. used in concrete or the curing and repair of concrete, which can contact potable water, shall be certified as conforming to the requirements of ANSI/NSF 61 for contact with potable water when in the finished concrete.

2.2 CEMENTITIOUS MATERIALS

A. Cement:
   1. Portland cement, ASTM C 150, Type II.
   2. Use Portland cement made by a well-known acceptable manufacturer and produced by not more than one plant. Alternate cement sources may be used provided that a mix design has been accepted and a trial batch verifying performance has been made.
   3. Do not use cement which has deteriorated because of improper storage or handling.

B. Fly Ash Mineral Admixture:
   1. Mineral admixtures, when used, shall meet the requirements of ASTM C 618 Class F, except as follows:
      a. The loss on ignition shall be a maximum of 4 percent.
      b. The maximum percent of sulfur trioxide (SO_3) shall be 4.0.
   2. Fly ash shall be considered to be a cementitious material.
   3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.
   4. A substitution by weight, of the portland cement by fly ash, so that the total tricalcium aluminate content of the resulting cement plus fly ash is not greater than eight percent, will be considered. However, the fly ash shall not exceed 20 percent by weight of the cement plus fly ash.

C. Silica Fume Mineral Admixture:
   1. Silica fume mineral admixture shall be the dry compacted or slurry form and shall meet the requirements of ASTM C 1240. Silica Fume shall be considered to be a cementitious material. Application rate shall be seven percent by weight of cement, unless indicated otherwise.
   2. Product and Manufacturer: Provide one of the following:
      a. Rheomac SF100, as manufactured by Master Builders, Inc.
      b. Force 10,000 D, as manufactured by W.R. Grace & Company.
      c. Sikacrete 950 DP, as manufactured by Sika Corporation.
      d. Eucon MSA, as manufactured by the Euclid Chemical Company.
      e. Or equal.

2.3 AGGREGATES

A. General:
   1. Aggregates shall conform to the requirements of ASTM C 33 and as herein specified.
   2. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.

B. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
   1. Dune sand, bank run sand and manufactured sand are not acceptable.

C. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
   1. Crushed stone, processed from natural rock or stone.
   2. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.

2.4 WATER

A. Water used in the production and curing of concrete shall be clean and free from injurious amounts of oils, acids, alkalis, organic materials or other substances that may be deleterious to concrete or steel.

2.5 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instructions. All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by ENGINEER.

B. Air-Entraining Admixtures: ASTM C 260.
   1. Product and Manufacturer: Provide one of the following:
      a. SIKA AER or SIKA AEA-15, as manufactured by Sika Corporation.
      b. MB-VR, as manufactured by Master Builders, Inc.
      c. Daravair, as manufactured by W.R. Grace & Company.
      d. Or equal.

C. Water-Reducing Admixture: ASTM C 494, Type A.
   1. Proportion all Type "1" and Type "2" concrete with non-air entraining, normal setting, water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. The admixture shall not contain any lignin, nitrates or chlorides added during manufacture.
   2. Product and Manufacturer: Provide one of the following:
      a. Eucon WR-75, as manufactured by Euclid Chemical Company.
      b. Pozzolith series, as manufactured by Master Builders, Inc.

c. WRDA-15, as manufactured by W.R. Grace & Company.
d. Plastocrete 161 or Plastiment NS, as manufactured by Sika Corporation.
e. Or equal.

D. High Range Water-Reducing Admixture (HRWR): ASTM C 494, Type F/G.
1. High range water-reducer shall be used in classifications of concrete, where specified, and shall be permitted, at CONTRACTOR'S option, in all other classifications of concrete. It shall be added to concrete in compliance with the manufacturer's printed instructions. The specific admixture formulation shall be as recommended by the manufacturer for the project conditions. Provide one of the following:
a. Sikament series, as manufactured by Sika Corporation.
b. Rheobuild series, as manufactured by Master Builders, Inc.
c. Daracem-100, as manufactured by W.R. Grace & Company.
d. Eucon 37 or Eucon 537, as manufactured by the Euclid Chemical Company.
e. Or equal.

E. Set-Control Admixtures: ASTM C 494, as follows:
1. Type B, Retarding.
2. Type C, Accelerating.
3. Type D, Water-reducing and Retarding.
4. Type E, Water-reducing and Accelerating.
5. Type F, Water-reducing, high range admixtures.
6. Type G, Water-reducing, high range, and retarding admixtures.

F. Calcium Chloride: Calcium chloride shall not be used.

G. Shrinkage Reducing Admixture
1. A shrinkage reducing admixture shall be permitted to be used in the mix design where necessary to meet specified shrinkage limitations provided that specified strength requirements are met and there is no reduction in sulfate resistance and no increase in permeability.
2. Shrinkage reducing admixtures shall be one of the following:
a. Eclipse, as manufactured by Grace Construction Products.
b. Tetraguard AS20, as manufactured by Master Builders, Inc.
c. Or equal.

H. If super plasticizers are used in mix designs, the mix shall be slumped at jobsite prior to addition of plasticizer.

2.6 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes subject to the following limitations:

Classification Min. Comp.	Coarse Aggregate[1]		Minimum Cementious (lbs/cu yd)	Maximum W/C	Slump[2]	Air (%)	Strength[3] (psi)
	Size A	Size B					
Type "1"	#57	#8	564	0.40	4" Max.	6+/-1	4500

Type “2”	#57 or #67	517	0.50	4" Max. 6+/-1	3000
Type “4”	Any ASTM C 33	<----------no requirements---------->			2000

1. Coarse aggregate size numbers refer to ASTM C 33. Where a size A and B are listed, it is intended that the smaller size B aggregate is to be added, replacing a portion of the coarse and /or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with a sand content not exceeding 41 percent of total aggregate.
2. The slumps listed are prior to the addition of high range water reducer (super plasticizer)
3. Mix designs shall be made for all but Type “4”, which does not require a trial batch, so that the compressive strength achieved for the laboratory trial batches will be no less than 125 percent of the specified design strength. This is to assure meeting the design strength for all concrete batched during the project.
4. The quantity of water to be used in the determination of the water-cementitious materials ratio shall include free water on aggregates in excess of SSD and the water portion of admixtures.

B. Use an independent testing facility acceptable to ENGINEER for preparing and reporting proposed mix designs.
   1. The testing facility shall not be the same as used for field quality control testing.

C. Submit written reports of laboratory trial batch test results for proposed mixes of concrete to ENGINEER at least 15 days prior to start of Work. Do not begin concrete production until mixes have been approved by ENGINEER.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by CONTRACTOR when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the OWNER and as accepted by ENGINEER. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by ENGINEER before using the revised mixes.

E. Admixtures:
   1. Use air-entraining admixture in all concrete, unless otherwise shown or specified. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the prescribed limits.
   2. Water reducing or high-range water reducing admixtures shall be used in all Type “1” concrete.
   3. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

F. Slump Limits with High Range Water Reducer
   1. Slump shall not exceed 3-inches prior to adding high range water-reducer and shall not exceed 7.5 inches, measured at point of placement, after adding high range water reducer.

G. Shrinkage Limitation

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 28-day drying age shall be 0.032 percent. Only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to Type “1” concretes.
2. If the trial batch results fail to meet the shrinkage limitation, the mix shall be redesigned to reduce shrinkage. Alternately, CONTRACTOR may use a higher shrinkage mix when acceptable to the ENGINEER provided that the amount of shrinkage reinforcement in the structures is increased as determined by the ENGINEER to resist the higher levels of shrinkage stresses. The additional reinforcing shall be provided at CONTRACTOR'S expense.

H. Color: Provide colored concrete where shown on the Drawings and specified. Incorporate pigments into the concrete mix according to manufacturer's written instructions. Match sample color approved by ENGINEER.

2.7 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents as specified in Section 03 15 16, Concrete Construction Joints.

2.8 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Curing mats shall be heavy carpets or cotton mats, quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

C. Moisture Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
2. Polyethylene film.
3. White burlap-polyethylene sheet.

D. Curing Compound: ASTM C 309 Type 1-D (water retention requirements):
1. Product and Manufacturer: Provide one of the following:
   a. Super Aqua Cure VOX, as manufactured by The Euclid Chemical Company.
   b. Sealtight 1100, as manufactured by W.R. Meadows, Incorporated.
   c. MasterKure, as manufactured by Master Builders, Inc.
   d. Or equal.
2. Provide fugitive dye.
3. Curing compound must be applied by roller or power sprayer.

2.9 FINISHING AIDS

A. Evaporation Retardant:
1. Product and Manufacturer: Provide one of the following:
   a. Confilm, as manufactured by Master Builders.
   b. Eucobar, as manufactured by Euclid Chemical Company.
   c. SikaFilm by Sika Corporation.

d. Or equal.

2.10 CRACK INJECTION MATERIALS

A. Epoxy:
   1. Epoxy for injection shall be a low viscosity, high modulus moisture insensitive type.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, as manufactured by Sika Corporation.
      b. Eucopoxy Injection Resin, as manufactured by The Euclid Chemical Company.
      c. Or equal.

B. Hydrophilic Resin
   1. Hydrophilic resin shall be an acrylic-ester based resin with a maximum viscosity of 50 cps. It shall cure into a flexible rubber-like material that has the potential for unrestrained increase in volume in excess of 100 percent in the presence of water.
   2. Products and Manufacturers: Provide one of the following:
      a. Duroseal Inject, as manufactured by BBZ USA, Inc.
      b. Sika Injection 29, by Sika Corporation.
      c. Or equal.

2.11 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be a prepackaged polymer-modified cementitious repair mortar with the following minimum properties:
   1. Compressive strength at one day: 2000 psi (ASTM C 109).
   2. Compressive strength at 28 days: 6000 psi (ASTM C 109).
   3. Bond strength at 28 days: 1800 psi (ASTM C 882 modified).

B. Concrete repair mortar shall be:
   1. Five Star Structural Concrete, manufactured by Five Star Products, Inc. The formulation recommended by the manufacturer for the specific application conditions shall be used.
   2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, manufactured by the Sika Corporation. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
   3. Emaco S88-CA or S66-CR, manufactured by Master Builders Inc. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
   4. Verticoat, Verticoat Supreme, or Euco SR-VO, manufactured by the Euclid Chemical Company. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
   5. Or equal.

C. Cement Mortar: Cement mortar shall consist of a mix of one part cement to 1 1/2 parts sand with sufficient water to form a trowelable consistency. Minimum compressive strength at 28 days shall be 4000 psi. Where required to match the

color of adjacent concrete surfaces, white portland cement shall be blended with standard portland cement so that, when dry, the patching mortar shall match the color of the surrounding concrete.

2.12 CHEMICAL HARDENER

A. Provide a clear chemical hardener of the fluosilicate family.

B. Product and Manufacturer: Provide one of the following:
   1. Lapidolith, as manufactured by Sonneborn ChemRex Inc.
   2. Hornolith, as manufactured by A.C. Horn, Inc.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 CONCRETE MIXING

A. General:
   1. Concrete may be produced at batch plants or it may be produced by the ready-mixed process. Batch plants shall comply with the recommendations of ACI 304, and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of ENGINEER.
   2. Mixing:
      a. Mix concrete with an approved rotating type batch machine, except where hand mixing of very small quantities may be permitted.
      b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
      c. Replace mixer blades when they have lost ten percent of their original height.
      d. Use quantities such that a whole number of bags of cement is required, unless otherwise permitted.

B. Job Site Mixing: When job site mixing of concrete is permitted, mix all materials for concrete in an acceptable drum type batch machine mixer. For mixers of one cubic yard, or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than five minutes after all ingredients are in the mixer, before any part of the batch is released. For mixers of capacity larger than one cubic yard, increase the minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cubic yard, or fraction thereof. Do not exceed the catalog rating or Manufacturer nameplate capacity for the total volume of materials used per batch. Equip the mixer with automatic controls, or semi-automatic controls if acceptable, for proportioning

materials and the proper measured quantities. Do not exceed 45 minutes total elapsed time between intermingling of damp aggregates and cement to the discharge of the completed mix.

1. Provide a batch ticket for each batch discharged and used in the Work, indicating the project identification name and number, date, mix type, mix time, quantity and amount of water introduced.

C. Ready-Mix Concrete:
   1. Comply with the requirements of ASTM C 94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, must be accepted by ENGINEER before implementation.
      a. Plant equipment and facilities: Conform to National Ready-Mix Concrete Association "Plant and Delivery Equipment Specification".
      b. Mix concrete in revolving type truck mixers that are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
      c. Do not exceed the proper capacity of the mixer.
      d. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
      e. Do not allow the drum to mix while in transit.
      f. Mix at proper speed until concrete is discharged.
      g. Maintain adequate facilities at the job site for continuous delivery of concrete at the required rates.
      h. Provide access to the mixing plant for ENGINEER at all times.
   2. When silica fume is used in the dry compacted form, the following mix requirements shall be followed to ensure full dispersion.
      a. For all types of mixing equipment, mix times shall be increased by 40 percent over the minimum mix time required to achieve mix uniformity as defined by ASTM C 94.
      b. For truck-mixed and central mixed concrete, maximum allowable batch size shall be 80 percent of the maximum in accordance with ASTM C 94.

D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

3.3 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

3.4 PREPARTION FOR CONCRETING

A. All reinforcement, installation of waterstop and positioning of embedded items shall be inspected and approved by the ENGINEER a minimum of four hours prior to concrete placement.

B. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

C. All reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or any other substance which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.

D. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater, nor shall CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the ENGINEER.

E. Joint surfaces shall be prepared as required by Section 03 15 16, Concrete Construction Joints.

3.5 CONCRETE PLACEMENT

A. General: Place concrete continuously so that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified in Section 03 15 16, Concrete Construction Joints. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.
   1. Screed concrete that is to receive other construction to the proper level to avoid excessive skimming or grouting.
   2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
   3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and secure position.
   4. Unless otherwise approved, place concrete only when ENGINEER is present.
   5. Allow a minimum of three days before placing concrete against a slab or wall already in place.

B. Bonding for Next Concrete Pour:

1. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
   a. Thoroughly wet the surface, but allow no free standing water.
   b. For horizontal surfaces place a 2-inch layer of mortar, one part sand and one part cement with water added to a flowable consistency, or a 6-inch layer of Construction Joint Grout, as specified in Section 03 60 00, Grouting, over the hardened concrete surface.
   c. Place fresh concrete before the mortar/grout has attained its initial set.
   d. If a high range water reducer is used to increase the concrete slump to at least 6-inches, the mortar/grout layer may be omitted.
2. Bonding of fresh concrete to fully-cured hardened existing concrete shall be accomplished by using a bonding agent as specified in Section 03 15 16, Concrete Construction Joints.

C. Concrete Conveying:
1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods that will prevent segregation and loss of concrete mix materials.
2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, ice and other deleterious materials.
3. Do not use chutes for distributing concrete, unless approved in writing by ENGINEER.
   a. Provide sketches showing methods by which chutes will be employed when requesting such approval.
   b. Design chutes, if permitted, with proper slopes and supports to permit efficient handling of the concrete.
4. Pumping concrete is permitted, however do not use aluminum pipe for conveying.

D. Placing Concrete into Forms:
1. Deposit concrete in forms in horizontal layers not deeper than 18-inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete that is being integrated with fresh concrete is still plastic.
2. Do not permit concrete to free fall within the form from a distance exceeding four feet. Where high range water reducer is used to extend slump to at least 6- inches, the maximum free fall of concrete may be increased to six feet. If a 12-inch thick layer of construction joint grout, as specified in Section 03 15 16, Concrete Construction Joints, is placed on the horizontal joint, concrete with slump extended by a high range water reducer may free fall up to eight feet in walls that are 24-inches and thicker. Use "elephant trunks" to prevent free fall and excessive splashing on forms and reinforcement. Free falls in excess of four feet shall be discontinued if there is any evidence of segregation.
3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable

recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by ENGINEER.

5. Where height of concrete placement in walls exceeds 14 feet, temporary windows shall be installed in the formwork to facilitate vibration. The windows shall be properly closed when the height of concrete approaches the windows. Location, size, and spacing of the windows shall be determined by CONTRACTOR to suit equipment used.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6-inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
7. Do not place concrete in beam and slab forms until the concrete previously placed in columns and walls is no longer plastic.
8. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.

E. Placing Concrete Slabs:
1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified for formed concrete structures.
4. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.
5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, an evaporation retardant shall be applied in accordance with the manufacturer's recommendations, when required by the ENGINEER.

F. Quality of Concrete Work:
1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
2. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to the extent directed by ENGINEER, or repair to the satisfaction of ENGINEER, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering shall not be acceptable.
4. All leaks through concrete that exhibit any flowing water, and cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by CONTRACTOR.
5. Repair, removal, and replacement of defective concrete as directed by ENGINEER shall be at no additional cost to the OWNER.

G. Cold Weather Placing:
   1. Protect all concrete Work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
   2. When the air temperature has fallen to or may be expected to fall below 40°F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50°F and 70°F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall more than 30°F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
   3. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55°F and not more than 85°F at point of placement.
   4. Do not use salt and other materials containing antifreeze agents or chemical accelerators, or set-control admixtures, unless approved by ENGINEER, in mix designs.

H. Hot Weather Placing:
   1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
   2. When ambient air temperature is at or above 90°F, cool ingredients before mixing to maintain concrete temperature at time of placement below 80°F when the air temperature is rising and below 85°F when the air temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water. In addition, the reduction in time from addition of mix water to placement or the use of a set retarding admixture may be required.
   3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
   4. Wet forms thoroughly before placing concrete.
   5. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
   6. Do not use set-control admixtures, unless approved by ENGINEER in mix designs.
   7. Obtain ENGINEER'S approval of other methods and materials proposed for use.

3.6 FINISH OF FORMED SURFACES

A. Standard Form Finish:
   1. Standard form finish shall be basically smooth and even but shall be permitted to have texture imparted by the form material used. Defects shall be repaired as specified herein.
   2. Use standard form finish for the following:
      a. Exterior vertical surfaces from the foundation up to one foot below grade.

b. Vertical surfaces not exposed to view.
c. Other areas shown.

B. Smooth Form Finish:
1. Produce smooth form finish by selecting form materials that will impart a smooth, hard, uniform texture. Arrange panels in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas as specified herein.
2. Use smooth form finish for the following:
a. Exterior surfaces that are exposed to view.
b. Surfaces that are to be covered with a coating material. The material may be applied directly to the concrete or may be a covering bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.
c. Interior vertical surfaces of liquid containers.
d. Interior and exterior exposed beams and undersides of slabs.
e. Surfaces to receive an abrasive blasted finish.
f. Surfaces to receive a smooth rubbed or grout cleaned finish.
g. Other areas shown.

C. Smooth Rubbed Finish:
1. Provide smooth, Class A, rubbed finish to concrete surfaces, which have received smooth form finish and where all defects have been repaired, as follows:
a. Rubbing of concrete surfaces not later than the day after form removal.
b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
2. Except where surfaces have been previously covered as specified above, use smooth, Class A, rubbed finish for the following:
a. Interior exposed walls and other vertical surfaces.
b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid containers down to one foot below liquid level.
e. Other areas shown on the Drawings.

D. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.7 SLAB FINISHES

A. Float Finish:
1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the

concrete has stiffened sufficiently. Check and level the surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten-foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

2. Use float finish for the following:
   a. Interior exposed horizontal surfaces of liquid containers, except those to receive grout topping.
   b. Exterior below grade horizontal surfaces.
   c. Surfaces to receive additional finishes, except as shown or specified.

B. Trowel Finish:
1. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
2. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straight edge. Grind smooth surface defects that would telegraph through applied floor covering system.
3. Use trowel finish for the following:
   a. Interior exposed slabs, unless otherwise shown or specified.
   b. Slabs to receive resilient floor finishes.

C. Non-Slip Broom Finish:
1. Immediately after float finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fine fiber-bristle broom, unless otherwise directed by the ENGINEER. Coordinate the required final finish with ENGINEER before application.
2. Use Non-Slip Broom Finish for the following:
   a. Exterior exposed horizontal surfaces subject to light foot traffic.
   b. Interior and exterior concrete steps and ramps.
   c. Horizontal surfaces which will receive a grout topping or a concrete equipment base slab.

3.8 CONCRETE CURING AND PROTECTION

A. General:
1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
2. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from the concrete surface. Keep continuously moist for not less than 72 hours.
3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least seven days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least ten days. For concrete sections over 30-inches thick, continue final

curing for an additional seven days, minimum. Avoid rapid drying at the end of the final curing period.

B. Curing Methods:
   1. Water retaining and below grade structures shall be moist cured by the addition of water to maintain the surface in a continually wet condition. Other concrete shall be cured by moist curing, by moisture retaining cover curing, or by the use of curing compound. Use curing compound at water retaining and below grade structures only in cold weather and only when permitted by ENGINEER.
      a. For curing, use water that is free of impurities that could etch or discolor exposed, natural concrete surfaces.
   2. Provide moisture curing by any of the following methods:
      a. Keeping the surface of the concrete continuously wet by covering with water.
      b. Continuous water-fog spray.
      c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. If necessary, the curing cover shall be weighted to maintain contact with the concrete surface.
      d. At the end of the curing period apply one coat of curing compound, unless concrete surface is to receive a topping or coating or application is waived by the ENGINEER.
   3. Provide moisture retaining cover curing as follows:
      a. Cover the concrete surfaces with the specified moisture retaining cover for curing concrete, placed in the widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
   4. Provide liquid curing compound as follows:
      a. Apply the specified curing compound to all concrete surfaces when permitted by ENGINEER. Slabs to receive terrazzo floors, chemical resistant heavy duty concrete topping or ceramic tile, shall not be cured with liquid curing compound, but shall be moisture cured. The compounds shall be applied immediately after final finishing in a continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas that are subjected to heavy rainfall within three hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period. For concrete surfaces that will be in contact with potable water, the manufacturer shall certify that the curing compound meets the requirements of ANSI/NSF 61.
      b. When curing compound is authorized for application to water retaining or below grade members, it shall be applied at the manufacturer's recommended coverage rate and then applied again at the same rate to provide twice the recommended coverage.
      c. At the end of the curing period, curing compound shall be removed where required by the ENGINEER.

C. Curing Formed Surfaces:

1. Cure formed concrete surfaces; including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place unloosened for the full curing period or until forms are removed. Where wood forms are kept in place, water shall be added to keep the forms wet. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces:
   1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by using the appropriate method specified above.
   2. Final cure unformed surfaces, unless otherwise specified, by utilizing methods specified above, as applicable.

E. Temperature of Concrete During Curing:
   1. When the atmospheric temperature is 40°F and below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306.
   2. When the atmospheric temperature is 80°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305, unless otherwise specified.
   3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5°F in any one hour and 50°F in any 24 hour period.

F. Protection from Mechanical Injury:
   1. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.9 FIELD QUALITY CONTROL

A. The OWNER shall employ a testing laboratory to perform field quality assurance testing. ENGINEER will direct the number of tests and cylinders required. Make standard compression test cylinders and entrained air tests as specified below, under the direct inspection by ENGINEER. Also, provide all labor, material and equipment required including, scale, glass tray, cones, rods, molds, air tester, thermometer, curing in a heated storage box, and all other incidentals required. Above will be subject to approval by ENGINEER. Furnish all necessary storage and curing, as specified in Section 01 45 29.10, On-Site Facilities for Testing Laboratory, and transportation required by the testing.

B. Contractor Quality Control Testing During Construction:
   1. Perform sampling and testing for field quality control during the placement of concrete, as follows:

a. Sampling Fresh Concrete: ASTM C 172.
b. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
c. Air Content: ASTM C 231; one for every other concrete load at point of discharge, or when required by an indication of change.
d. Compressive Strength Tests: ASTM C 39; one set of compression cylinders for each 50 cubic yards or fraction thereof, of each mix design placed in any one day; one specimen tested at seven days, and three specimens tested at 28 days.
    1) Adjust mix if test results are unsatisfactory and resubmit for ENGINEER'S approval.
    2) Concrete that does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by ENGINEER, at the expense of CONTRACTOR.
e. Compression Test Specimens: ASTM C 31; make one set of four standard cylinders for each compressive strength test, unless otherwise directed.
    1) Cast, store and cure specimens as specified in ASTM C 31.
f. Concrete Temperature: Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens is made.

2. The testing laboratory shall submit certified copies of test results directly to ENGINEER and CONTRACTOR within 24 hours after tests are made.

C. Evaluation of Quality Control Tests:
1. Do not use concrete delivered to the final point of placement, which has slump or total air content outside the specified values.
2. When water content testing indicates water-cementitious materials ratio to exceed specified requirements by more than 0.02, remaining batches needed to complete the concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as needed to bring the subsequently batched concrete within the specified water-cementitious materials ratio. Additional testing shall be done to verify compliance with the specified water-cementitious materials ratio. Concrete production for further concrete placements shall not resume until CONTRACTOR has identified the cause of the excess water in the mix and revised batching procedures and/or adjustments to mix design needed to bring water-cementitious materials ratio into conformance with specified requirements have been accepted by Engineer.
3. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 28-day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
    a. Where questionable field conditions may exist during placing concrete or immediately thereafter, strength tests of specimens cured under field conditions will be required by ENGINEER to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded at the same time and from the same samples as the laboratory cured specimens.

1) Provide improved means and procedures for protecting concrete when the 28-day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders.
2) When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strengths need not exceed the minimum required compressive strength by more than 500 psi even though the 85 percent criterion is not met.
3) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question will be required at CONTRACTOR'S expense.

b. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to replacement, reconstruction or to other action approved by ENGINEER.

D. Testing Concrete Structure for Strength:
1. When there is evidence that the strength of the in-place concrete does not meet specification requirements, employ at CONTRACTOR'S expense the services of a concrete testing service to take cores drilled from hardened concrete for compressive strength determination. Tests shall comply with the requirements of ASTM C 42 and the following:
   a. Take at least three representative cores from each member or suspect area at locations directed by ENGINEER.
   b. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85 percent and no single core is less than 75 percent of the 28-day required compressive strength.
   c. Report test results to ENGINEER, in writing, on the same day that tests are made. Include in test reports, the Project identification name and number, date, name of CONTRACTOR, name of concrete testing service, location of test core in the structure, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.
2. Fill core holes solid with non-shrink, high strength grout, and finish to match adjacent concrete surfaces.
3. Conduct static load test and evaluations complying with the requirements of ACI 318 if the results of the core tests are unsatisfactory, or if core tests are impractical to obtain, as directed by ENGINEER.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings
   1. Openings in concrete walls and/or slabs required for passage of Work or installation of equipment and not shown on the Drawings shall be provided, but only with approval of the ENGINEER.
   2. All temporary openings made in concrete shall be provided with waterstop in below grade or water retaining members. Continuity of required reinforcement shall be provided in a manner acceptable to the ENGINEER.
   3. Temporary openings left in concrete structures shall be filled with concrete after the Work causing the need for the opening is in place, unless otherwise shown or directed. Mix, place and cure concrete as specified herein, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.

B. Equipment Bases:
   1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. Coordinate and construct bases to the dimensions shown, or as required to meet manufacturers requirements and Drawing elevations. Where no specific elevations are shown, bases shall be 6-inches thick and extend 3-inches outside the metal equipment base or supports. Bases shall have smooth trowel finish, unless noted otherwise.
   2. Include all concrete equipment base work not specifically included under other Sections.
   3. In general, place bases up to 1-inch below the metal base. Properly shim equipment to grade and fill 1-inch void with non-shrink grout as specified in Section 03 60 00, Grouting.

C. Curbs:
   1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
   2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

D. Slabs/Foundations:
   1. All mechanical pipe and electrical conduit penetrations through concrete slabs must be sleeved.

3.11 CONCRETE REPAIRS

A. Repair of Formed Surfaces:
   1. The following defects shall be repaired in all types of formed finishes:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
      b. Holes from tie rods and other form tie systems.
      c. Fins, offsets and other projections that extend more than 1/4-inch beyond the designated member surface.
      d. Structural cracks, as defined by the ENGINEER.
      e. Non-structural cracks, as defined by the ENGINEER, which are greater than 0.010-inch wide. In water retaining members, elevated slabs subject to rainfall and washdown, and below grade members, any crack that shows any amount of leakage. Where it is not possible to verify that a crack is not leaking, it shall be repaired.

2. The following defects shall be repaired in smooth finish surfaces, in addition to those listed above:
    a. Spalls, air bubbles, rock pockets, form depressions, and other defects which extend to more than 1/2-inch in width in any direction, no matter how deep.
    b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch square or 12 in number in a three-foot square.
    c. Fins, offsets and other projections shall be completely removed and smoothed.
    d. Scratches and gouges in the surface.
    e. Texture and color irregularities. At water retaining surfaces, texture and color irregularities need not be repaired when greater than 12-inches below the minimum normal operating water surface, except where such defects are indicative of reduced durability.
3. Where a smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to the finish application, when approved by the ENGINEER.

B. Method of Repair of Formed Surfaces:
1. Repair and patch defective areas with cement mortar or concrete repair mortar immediately after removal of forms and as directed by ENGINEER. Repairs made to water bearing and buried surfaces shall be made with repair mortar only. Repairs of form tie holes on water bearing or buried surfaces shall be made with non-shrink grout as specified in Section 03 60 00, Grouting.
2. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean and brush-coat the area to be patched with the specified bonding agent. Where concrete repair mortar is used, bonding agent shall be optional and the surface prepared and mortar placed per manufacturers recommendations.
    a. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for the interior surfaces of liquid containers up to one foot below liquid level. Impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.
3. Structural cracks shall be pressure grouted using an injectable epoxy using a pumped pressure system. Apply in accordance with the manufacturer's directions and recommendations.
4. Non-structural cracks shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
5. Determination of the crack type shall be made by the ENGINEER.
6. Fill holes extending through concrete by means of a plunger- type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure completely filling. At below grade and water retaining members, fill holes with concrete repair mortar except use a color matched cement mortar for the outer 2-inches at exposed to view surfaces.

7. Where powerwashing and/or scrubbing is not adequate, abrasive blast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair of Unformed Surfaces:
   1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
   2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
   3. Repair finish of unformed surfaces that contain defects that adversely affect the durability of the concrete. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
   4. Repair structural cracks in all structures and non-structural cracks in water-holding structures. In water-holding structures, where the dry face of the concrete member can be observed, cracks that show any rate of water flow shall be repaired. Where the dry face of the member cannot be observed, all cracks shall be repaired.

D. Methods of Repair of Unformed Surfaces:
   1. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
   2. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where the concrete has already set and repairs are required, sawcut around the perimeter of the area to be repaired to a 1/2-inch depth and remove concrete so that the minimum thickness of the repair is 1/2-inch. Apply specified concrete repair mortar in accordance with the manufacturer's directions and recommendations.
   3. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. The minimum thickness of the repair shall be 1.5-inches. Dampen all concrete surfaces in contact with patching concrete and brush with the specified bonding agent. Place patching concrete while the bonding agent is still tacky. Mix patching concrete of the same materials and proportions to provide concrete of the same classification as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
   4. Repair isolated random non-structural cracks (in members which are not below grade or water retaining), and single holes not over 1-inch diameter, by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part

portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

5. Structural cracks shall be pressure grouted using an injectable epoxy. Apply in accordance with the manufacturer's directions and recommendations.
6. Non-structural cracks in below grade and water retaining structures shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
7. Determination of the crack type shall be made by the ENGINEER.
8. Assure that surface is acceptable for flooring material to be installed in accordance with manufacturer's recommendations.

E. Other Methods of Repair:
   1. Repair methods not specified above may be used if approved by ENGINEER.

+ + END OF SECTION + +

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SECTION 03 60 00

GROUTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout.
   2. The types of grout include the following:
      a. Non-Shrink Grout: This type of grout is to be used wherever grout is shown in the Contract Documents, unless another type is specifically referenced. Two classes of non-shrink grout (Class I and II) and areas of application are specified herein.
      b. Non-Shrink Epoxy Grout (Class III).
      c. Grout Fill, Topping Grout.
      d. Construction Joint Grout.

B. Application: The following is a listing of typical applications and the corresponding type of grout which is to be used. Unless indicated otherwise, grouts shall be provided as listed below whether called for on the Drawings or not.

Application		Type of Grout
Beam and column (1 or 2 story) base plates and precast concrete bearing less than 16-inches in the least dimension.		Non-shrink Class II
Column base plates and precast concrete bearing (greater than 2 story or larger than 16-inches in the least dimension).		Non-shrink Class I
Base plates for storage tanks and other non-motorized equipment and machinery less than 30 horsepower.		Non-shrink Class I
Machinery over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibration.		Non-shrink Class III
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.		Non-shrink Class II (Class I where placement time exceeds 15 minutes)
Toppings and concrete fill less than 4-inches thick.		Grout Fill, Topping Grout

Application		Type of Grout
Toppings and concrete fill greater than 4-inches thick.		Type “1” Concrete in accordance with Section 03 30 00, Cast-In-Place Concrete.
All anchor bolts and reinforcing steel set in grout.		Refer to Section 03 20 00, Concrete Reinforcing, and Section 03 15 19, Anchorage in Concrete.
Any application not listed above, where grout is called for on the Drawings.		Non-shrink Class I, unless noted otherwise

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavy-Weight and Mass Concrete.
   2. ACI 301, Specification for Structural Concrete (Includes ASTM Standards referred to herein).
   3. ASTM C 33, Specification for Concrete Aggregates.
   4. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
   5. ASTM C 150, Specification for Portland Cement.
   6. ASTM C 230, Specification for Flow Table for use in Tests of Hydraulic Cement.
   7. ASTM C 531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical- Resistant Mortars, Grouts, and Monolithic Surfacings.
   8. ASTM C 579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.
   9. ASTM C 827, Test Method for Early Volume Change of Cementitious Mixtures.
   10. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
   11. ASTM C 937, Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.
   12. ASTM C 939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   13. ASTM C 1107, Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   14. ASTM C 1181, Test Method for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   15. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics.

B. Field Tests:
   1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the

ENGINEER to ensure continued compliance with these specifications. The specimens will be made by the ENGINEER or its representative.

2. Compression tests and fabrication of specimens for non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, 28 days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, and each earlier time period as appropriate.
4. The cost of all laboratory tests on grout will be borne by the OWNER, but CONTRACTOR provide assistance to the ENGINEER in obtaining specimens for testing. However, the cost of any additional tests and investigation on work performed which does not conform to the requirements of the specifications belongs to CONTRACTOR. Supply all materials necessary for fabricating the test specimens.

1.3 SUBMITTALS

A. Shop Drawings, submit for approval the following:
   1. For Grout Fill and Construction Joint Grout, copies of grout design mix and laboratory test reports for grout strength tests.

B. Reports and Certificates, submit for approval the following:
   1. For proprietary materials, submit copies of manufacturer's certification of compliance with the specified properties for Class I, II, and III grouts.
   2. Submit certified testing lab reports for ASTM C 1107, Grade B and Grade C (as revised herein) requirements for Class I and II grouts tested at a fluid consistency for temperatures of 45, 73.4, 90°F with a pot life of 30 minutes at fluid consistency.
   3. Submit certification that materials meet specification requirements for nonproprietary materials.
   4. Submit certifications that all grouts used on the project are free of chlorides or other chemicals causing corrosion.
   5. Manufacturer's specifications and installation instructions for all proprietary materials.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Grout materials from manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.

B. Storage of Materials: Grout materials shall be stored in a dry shelter and shall be protected from moisture.

PART 2 - PRODUCTS

2.1 GROUTS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which

the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.

B. Class I Non-Shrink Grout:
   1. Class I non-shrink grouts shall have a minimum 28-day compressive strength of 7000 psi. This grout is for precision grouting and where water tightness and non-shrink reliability in both plastic and hardened states are critical. Refer to areas of application as specified herein.
   2. Shall meet the requirements of ASTM C 1107 Grade C and B (as modified below) when tested using the amount of water required to achieve the following properties:
      a. Fluid consistency (20 to 30 seconds) in accordance with ASTM C 939
      b. At temperatures of 45, 73.4, and 95°F.
   3. The length change from placement to time of final set shall not have a shrinkage greater than the amount of expansion measured at 3 or 14 days. The expansion at 3 or 14 days shall not exceed the 28-day expansion.
   4. The non-shrink property is not based on a chemically generated gas or gypsum expansion.
   5. Fluid grout shall pass through the flow cone, with a continuous flow, one hour after mixing.
   6. Product and Manufacturer: Provide one of the following:
      a. Masterflow 928, as manufactured by Master Builders, Inc.
      b. Five Star Grout, as manufactured by Five Star Products, Inc.
      c. Hi-Flow Grout, as manufactured by the Euclid Chemical Company
      d. Or equal.

C. Class II Non-Shrink Grout:
   1. Class II non-shrink grouts shall have a minimum 28-day compressive strength of 7000 psi. This grout is for general purpose grouting applications as specified herein.
   2. Shall meet the requirements of ASTM C 1107 and the following requirements when tested using the amount of water required to achieve the following properties:
      a. Flowable consistency (140 percent flow on ASTM C 230, five drops in 30 seconds.)
      b. Fluid working time of at least 15 minutes.
      c. Flowable for at least 30 minutes.
   3. The grout when tested shall not bleed at maximum allowed water.
   4. The non-shrink property is not based on a chemically generated gas or gypsum expansion.
   5. Product and Manufacturer: Provide one of the following:
      a. Set Grout, as manufactured by Master Builders, Inc.
      b. NBEC Grout, as manufactured by Five Star Products, Inc.
      c. NS Grout, as manufactured by the Euclid Chemical Company.
      d. Or equal.

D. Class III Non-Shrink Epoxy Grout:
   1. Epoxy grout shall be a pourable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl

glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted, unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. The following properties shall be attained with the minimum quantity of aggregate allowed by the manufacturer.

2. Product and Manufacturer: Provide one of the following:
   a. Euco High Strength Grout, as manufactured by The Euclid Chemical Company.
   b. Sikadur 42 Grout Pak, as manufactured by Sika Corporation.
   c. Five Star Epoxy Grout, as manufactured by Five Star Products, Incorporated.
   d. Or equal.
3. The vertical volume change at all times before hardening shall be between 0.0 percent shrinkage and 4.0 percent expansion when measured according to ASTM C 827 (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1). Alternately, epoxy grouts which maintain an effective bearing area of not less than 95 percent are acceptable.
4. The length change after hardening shall be negligible (less than 0.0006 in/in) and the coefficient of thermal expansion shall be less than 0.00003 in/in/F when tested in accordance to the requirements of ASTM C 531.
5. The compressive creep at one year shall be negligible (less than .001 in/in) when tested under a 400 psi constant load at 140°F in accordance to the requirements of ASTM C 1181.
6. The seven-day compressive strength shall be a minimum of 14,000 psi when tested in accordance to the requirements of ASTM C 579
7. The grout shall be capable of maintaining at least a flowable consistency for a minimum of 30 minutes at 70°F.
8. The shear bond strength to portland cement concrete shall be greater than the shear strength of the concrete when tested in accordance to the requirements of ASTM C 882.
9. The effective bearing area shall be a minimum of 95 percent.

E. Grout Fill, Topping Grout:
1. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as specified herein. All materials and procedures specified for normal concrete in Section 03 30 00, Cast-In-Place Concrete, shall apply except as noted otherwise herein.
2. Topping grout and concrete fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete fill is thicker than 4-inches, Type “1” concrete, as specified in Section 03 30 00, Cast-In-Place Concrete, may be used when accepted by the ENGINEER.
3. Coarse aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2-inch	100
3/8-inch	90-100
No. 4	20-55
No. 8	5-30

No. 16	0-10
No. 30	0

4. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.
5. Strength: Minimum compressive strength of Grout Fill at the end of 28 days shall be 4000 psi.

F. Construction Joint Grout:
1. Construction Joint Grout approximates Type "1" concrete, as specified in Section 03 30 00, Cast-In-Place Concrete, with aggregate coarser than 1/2-inch removed. The mix is to be designed as flowable with a high mortar content. It is intended to be placed over construction joints and mixed with Type "1" concrete as specified in Section 03 30 00, Cast-In-Place Concrete. The mix requirements are as follows:
   a. Compressive Strength: 4,500 psi minimum at 28-days.
   b. Maximum Water-Cement Ratio: 0.45 by weight.
   c. Coarse Aggregate: ASTM C33, No. 8 size.
   d. Fine Aggregate: ASTM C33, approximately 60 percent by weight of total aggregate.
   e. Air Content: 8±1 percent.
   f. Minimum Cement Content: 752 pounds per cubic yard.

G. Requirements for Grout Fill and Construction Joint Grout
1. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for grout required. Comply with ACI 211.1 and report to ENGINEER the following data:
   a. Complete identification of aggregate source of supply.
   b. Tests of aggregates for compliance with specified requirements.
   c. Scale weight of each aggregate.
   d. Absorbed water in each aggregate.
   e. Brand, type and composition of cement.
   f. Brand, type and amount of each admixture.
   g. Amounts of water used in trial mixes.
   h. Proportions of each material per cubic yard.
   i. Gross weight and yield per cubic yard of trial mixtures.
   j. Measured slump.
   k. Measured air content.
   l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven day and 28-day test, and for each design mix.
2. Submit written reports to ENGINEER of proposed mix of grout at least 30 days prior to start of Work. Do not begin grout production until mixes have been approved by ENGINEER.
3. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301, Section 4 - Proportioning. However, mixes need not be designed for greater than 125 percent of the specified strength, regardless of the standard deviation of the production facility.
4. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301, Section 4.

5. Admixtures: Use air-entraining admixture in all grout. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control. Do not use admixtures which have not been incorporated and tested in the accepted design mix, unless otherwise authorized in writing by ENGINEER.

2.2 CURING MATERIALS

A. Curing materials shall be as specified in Section 03 30 00, Cast-in-Place Concrete, and as recommended by the manufacturer of prepackaged grouts.

2.3 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

B. The slump for topping grout and grout fill shall be adjusted to match placement and finishing conditions, but shall not exceed 4-inches.

C. The slump for Construction Joint Grout shall be 7 ± 1-inches.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which grout is to be placed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General:
   1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until ENGINEER provides clarification.
   2. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
   3. Placing grout shall conform to temperature and weather limitations in Section 03 30 00, Cast-In-Place Concrete.
   4. Grout shall be cured following manufacturer’s instructions for prepackaged grout and the requirements in Section 03 30 00, Cast-In-Place Concrete, for grout fill and topping grout.

B. Columns, Beams and Equipment Bases:
   1. Epoxy grout: After shimming equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates, allowing sufficient room

around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the epoxy grout.

2. Non-shrink, non-metallic grout: After shimming columns, beams and equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the non-shrink, non-metallic grout.

C. Handrails and Railings:
1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink, non-metallic grout. Bevel grout at juncture with post so that moisture flows away from post.

D. Construction Joints:
1. Place a 6-inch minimum thick layer of Construction Joint Grout over the contact surface of the old concrete at the interface of horizontal construction joints as specified in Section 03 15 16, Concrete Construction Joints, and Section 03 30 00, Cast-In-Place Concrete.

E. Topping Grout:
1. All mechanical, electrical, and finish work shall be completed prior to placement of topping grout. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.
2. The minimum thickness of grout topping shall be 1-inch.
3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement slurry shall be broomed into the surface of the slab and topping or fill concrete shall be placed while the slurry is still wet. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.
6. Cure and protect the grout topping as specified in Section 03 30 00, Cast-In-Place Concrete.

F. Grout Fill

1. All mechanical, electrical, and finish work shall be completed prior to placement of grout fill. Grout fill shall be mixed, placed, and finished as required in Section 03 30 00, Cast-In-Place Concrete.
2. The minimum thickness of grout fill shall be 1-inch. Where the finished surface of grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2-inches wide by 1-1/2-inches deep.
3. The surface shall be tested with a straight edge to verify that the surface slopes uniformly to drain and to detect high and low spots which shall be immediately eliminated. When the grout fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

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SECTION 04 05 13

MORTAR AND MASONRY GROUT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install all mortar and masonry grout for unit masonry construction.
2. This Section specifies the mortar and masonry grout for masonry materials specified.
3. Types of products required include the following:
   a. Portland cement-lime mortars.
   b. Masonry cement mortars.
   c. Fine grout.
   d. Coarse grout.
   e. Grout fill around reinforcement in masonry lintels and bond beams.
   f. Epoxy pointing mortar.
   g. Mortar waterproofing admixtures, inorganic pigments and other miscellaneous mortar components and additives.

1.2 QUALITY ASSURANCE

A. Codes: Comply with the applicable requirements of the Phoenix Building Code for types of mortar work specified.

B. Source Quality Control:
1. Do not change source or brands of mortar materials during the course of the Work.
2. Where questions of compliance with the requirements of this Section arise, the specifications for mortar properties shall take precedence over the specification for mortar proportions.
3. No change shall be made in the proportions established for mortar approved under the specifications for mortar properties nor shall materials with different physical characteristics be utilized in mortar used in the Work, unless compliance with the requirements of the specifications for mortar properties are re-established by Shop Drawing data submission to ENGINEER.
4. Two different air-entraining materials shall not be combined in mortar.
5. Provide mortar Work complying with the requirements for special inspection as determined by the Phoenix Building Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
2. ASTM C 5, Specification for Quicklime for Structural Purposes.
3. ASTM C 91, Specification for Masonry Cement.
4. ASTM C 144, Specification for Aggregate for Masonry Mortar.
5. ASTM C 150, Specification for Portland Cement.

6. ASTM C 207, Specification for Hydrated Lime for Masonry Purposes.
7. ASTM C 270, Specification for Mortar for Unit Masonry.
8. ASTM C 404, Specification for Aggregates for Masonry Grout.
9. ASTM C 476, Specification for Grout for Masonry.
10. UL, Design Numbers U901 through U914.
11. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications and instructions for each manufactured product.
   2. Schedule of locations where each mortar type will be used in the Work.
   3. Product specification data for integral waterproofing admixture.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers, plainly marked with identification of materials and manufacturer.
   2. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage of Materials:
   1. Store mortar materials off the ground in a dry location and under a properly constructed shelter using tarpaulins, felt paper, or polyethylene sheets.
   2. Protect liquid admixtures from freezing.
   3. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement: Provide the following for Portland cement-lime mortars:
   1. ASTM C 150:
      a. Use Type I, when installation temperature is 50°F or higher.
      b. Use Type III, high early strength, when installation temperature is lower than 50°F.
   2. Provide non-staining Portland cement of natural color or of the color.
   3. Product and Manufacturer: Provide one of the following:
      a. Speed Portland Cement and Hi-Speed Portland Cement by Louisville Cement Company.
      b. Atlas Type I and Atlas Type III Portland Cement by Lehigh Portland Cement Company.
      c. White Portland Cement by Ideal Basic Industries.
      d. Or equal.

B. Masonry Cement: Provide the following for masonry cement mortars:
   1. ASTM C 91, Type S: proportioned as specified to comply with ASTM C 270.

2. Maximum Air Content, ASTM C 91: 18 percent.
3. Non-staining and of the color required to be compatible with the required colored mortar pigment selected by ENGINEER.
4. Product and Manufacturer: Provide one of the following:
   a. Brixment-in Color Type S by Louisville Cement Company.
   b. Atlas Custom Color Masonry Cement Type S by Lehigh Portland Cement Company.
   c. Or equal.

C. Hydrated Lime: ASTM C 207, Type S, or lime putty ASTM C 5.

D. Sand Aggregates:
1. ASTM C 144, except for joints less than 1/4-inch use aggregate graded with 100 percent passing the No. 16 sieve.
2. White Mortar Aggregates: Provide natural white sand or ground white stone for Portland Cement-lime mortars.
4. Fine Aggregate for Grout: Sand, ASTM C 404, Size No. 1.
5. Coarse Aggregate for Grout: ASTM C 404, Size No. 8 or Size No. 89.

E. Water: Free from injurious amounts of oils, acids, alkalis, or organic matter, and clean, fresh and potable.

F. Waterproofing Admixture for Exterior Masonry Mortar:
1. Provide a cross-linked acrylic polymer integral waterproofing system.
2. Proportion: In strict accordance with manufacturer's instructions.
3. Product and Manufacturer: Provide one of the following:
   a. DRY-BLOCK Mortar Admix by Forrer Industries, a Unit of W. R. Grace & Company Construction Products Division.
   b. ADDIMENT Block Plus W-10 by Addiment Incorporated.
   c. Or equal.

2.2 MORTAR MIXES

A. General:
1. Anti-Freeze Admixture or Agents: Not permitted.
2. Calcium Chloride: Not permitted.

B. Mortar for All Unit Masonry: Comply with ASTM C 270, Table 2, except limit materials to those specified herein. Do not substitute ASTM C 91 masonry cement for ASTM C 150 Portland cement without an approved Shop Drawing and a complete chemical analysis of the material and its properties. Limit cement-to-lime ratio by volume as follows:
1. Type S:
   a. Provide the following proportions by volume:
      1) Portland Cement: One part.
      2) Hydrated Lime or Lime Putty: Over 1/4 to 1/2 maximum.
      3) Aggregate Ratio (measured in damp loose condition): Not less than 2-1/4 and not more than three times the sum of the volumes of cementitious materials.
   b. Provide the following proportions by volume:
      1) Portland Cement: 1/2 part.

2) Masonry Cement: One part.
3) Aggregate Ratio (measured in a damp loose condition): Not less than 2-1/4 and not more than three times the sum of the volumes of cementitious materials.

c. Properties:
1) Average Compressive Strength, ASTM C 270: 1800 pounds per square inch.
2) Minimum Water Retention, ASTM C 270: 75 percent.
3) Maximum Air Content, ASTM C 270: 18 percent.

C. Grout:
1. Fine Grout:
a. Provide the following proportions by volume:
1) Portland Cement: One part.
2) Hydrated Lime or Lime Putty: 0 to 1/10 part.
3) Aggregate Ratio (measured in a damp loose condition): Sand; not less than 2-1/4 and not more than three times the sum of the volumes of cementitious materials.
b. Mix grout to have a slump of 10-inches plus or minus 1-inch, at time of placement.
2. Coarse Grout:
a. Provide the following proportions by volume:
1) Portland Cement: One part.
2) Hydrated Lime or Lime Putty: 0 to 1/10 part.
3) Fine Aggregate Ratio (measured in a damp loose condition): Sand; not less than 2-1/4 and not more than three times the sum of the volumes of cementitious materials.
4) Coarse Aggregate Ratio: Not less than one and not more than two times the sum of the volumes of cementitious materials.
b. Mix grout to have a slump of 10-inches plus or minus 1-inch, at time of placement.
3. Grout Fill Around Reinforcement in Masonry Lintels: Portland cement, sand, gravel and water, to be proportioned as required to provide a 28-day minimum compressive strength of 2,000 pounds per square inch.

D. Waterproofing Additive: Add to mix following manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measurement of Materials:
1. Cement and Hydrated Lime: Batched by the bag.
2. Sand: Batched by volume in suitably calibrated containers. Make allowance for bulking and consolidation, and for weight per cubic foot of contained moisture.
3. Proportion of Volumetric Mixtures: One 94-pound sack of portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
4. Shovel measurement: Not permitted.

B. Mortar Mixing:

1. Type of Mixer: Machine mix in approved mixer in which the quantity of water is accurately and uniformly controlled.
2. While mixer is in operation, add approximately 3/4 the required water, 1/2 the sand, all the cement, then add remainder of sand.
3. Allow batch to mix briefly, and then add water in small quantities until satisfactory workability is obtained.
4. Mix for not less than five minutes after all materials have been added.
5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn materials over together for each batch until the even color of the mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout the mass, and then add water to obtain required plasticity.
6. Lime putty, if approved for use, shall be prepared in accordance with ASTM C 5.
7. Waterproofing Admixture: Add to mortar mix for all exterior masonry in strict accordance with manufacturer's instructions.
8. The mixer drum shall be completely emptied before recharging the next batch.
9. Limit batch size to avoid retempering. Retempering of mortar will not be permitted.

3.2 INSTALLATION

A. Refer to Section 04 20 00, Unit Masonry Construction.

3.3 FIELD QUALITY CONTROL

A. Engage the services of an independent testing laboratory acceptable to ENGINEER, to collect samples and conduct tests to evaluate air entrainment, water retention, the compliance of materials with the Specifications and to determine the compressive strength of mortar and grout. Tests shall be conducted in accordance with ASTM C 91. Tests results shall be made available to ENGINEER prior to the commencement of Work.

B. After the initial test, provide a maximum of five additional tests to be conducted as directed by the ENGINEER.

+ + END OF SECTION + +

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SECTION 04 05 23

MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish masonry accessories.
   2. Types of products required include the following:
      a. Continuous horizontal wire reinforcing.
      b. Anchoring and positioning devices.
      c. Miscellaneous masonry accessories, reinforcing bars, compressible filler and premolded control joint strips.

1.2 QUALITY ASSURANCE

A. Performance Criteria:
   1. Provide masonry accessories of sizes, dimensions and configurations coordinated with unit masonry construction system component sizes, dimensions, and configurations.
   2. Where continuous horizontal cavity wall reinforcement is specified as providing restraint for cavity wall insulation coordinate dimensions with thickness of cavity wall insulation specified for proper clearances.

B. Comply with the applicable requirements of the Phoenix Building Code for types of masonry accessories work shown and specified.

C. Provide all metal sheet, wire, plate and bar stock masonry accessories from the same manufacturer. Other types of miscellaneous masonry accessory items may each be from a single, but different, manufacturer.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
   2. ASTM A 36, Specification for Carbon Structural Steel.
   3. ASTM A 153, Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   4. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
   5. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   6. ASTM A 366, Specification for Commercial Steel Sheet, Carbon, Cold-Rolled.
   7. ASTM A 569, Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
   8. ASTM A 580, Specification for Stainless and Heat-Resisting Steel Wire.
   9. ASTM A 615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

10. ASTM A 663, Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
11. ASTM A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
12. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
13. UL, Design Numbers U901 through U908.
14. Phoenix Building Code.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. One unit or one modular length of each item specified.
   2. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications and installation instructions for each masonry accessory required. Include data substantiating that materials comply with specified requirements. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedure.
   2. Provide drawings and material schedules showing all dimensions and sizes of masonry accessories coordinated with unit masonry construction Work, and other Work in which masonry accessories will be embedded, be supported from, or restrain.
   3. Indicate methods for identifying and coordinating, at the site, the location and accurate placement of each masonry accessory in unit masonry construction as the Work progresses. Indicate by letter of transmittal that items, which must be installed in the shop, have been received in time for proper sequencing of the Work to avoid delays.
   4. Explanation of where each masonry accessory will be used in the Work, quantities purchased and intended spacings indicating compliance with code requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver accessories in original, unopened, and undamaged packages, plainly marked with identification of materials and name of approved manufacturer. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage of Materials: Store and cover materials to prevent damage, corrosion, and deterioration. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements for Hazardous Materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Continuous Horizontal Wire Reinforcing and Ties: Provide the following for all masonry walls, unless otherwise shown:
   1. General:

a. All reinforcement, wire and ties of cold drawn steel wire complying with ASTM A1064, and hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.
b. Welded wire units prefabricated in straight lengths not less than 10 foot - 0 inches long, with matching corner "L" and intersection "T" units, all with deformed continuous 9 gage side rods and plain 9 gage truss-type diagonal cross-rods butt-welded to side rods not more than 16-inches on centers, with unit width of 1-1/2 to 2-inches less than thickness of wall or partition.
c. Rectangular boxes, pintles and ties fabricated of 3/16-inch diameter wire, unless otherwise specified.

2. Single-wythe Masonry Walls:
   a. Wall reinforcement system with one horizontal rod beneath each unit masonry face shell wall.
   b. Product and Manufacturer: Provide one of the following:
      1) Lox ◊ All Truss Reinforcement with #120 Truss-Mesh or #130/#140 Truss-Tri-Mesh by Hohmann & Barnard, Incorporated.
      2) Or equal.

B. Anchoring Devices for Masonry: Provide the following, unless otherwise shown:
   1. General:
      a. Cold rolled steel sheet complying with ASTM A366, hot-rolled steel sheet and strip complying with ASTM A569, plates and bars complying with ASTM A36 and cold drawn steel wire complying with ASTM A1064, All hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.
      b. Rectangular, corrugated, 1-inch-wide ties, fabricated of 12 gage sheet metal, unless otherwise specified.
      c. Size tie lengths to extend to within 1-inch of outside face of outer wythe face shell of opposite face of masonry or to a maximum depth of 12-inches and between 1-1/2 inches to 2-inches less than width of masonry abutting webs and to a maximum depth of 12-inches abutting flanges of structural supports. Provide wire crimped with a vee-drip for use in cavity wall construction.
      d. Flexible Anchors: Whenever masonry abuts structural walls or framework provide flexible anchors which permit horizontal and vertical movement of masonry, but provides lateral restraint.
   2. Rebar Positioners:
      a. Nine gage reinforcing bar positioners, which accommodate both horizontal and vertical reinforcing steel.
      b. Custom, made-to-order units as required for the Work.
      c. Product and Manufacturer:
         1) #RB Series and #RB-Twin Series Rebar Positioners by Hohmann & Barnard, Incorporated
         2) Or equal.

C. Miscellaneous Masonry Accessories:
   1. Reinforcing Bars:
      a. Deformed carbon steel, ASTM A 615, Grade 60.
      b. Plain carbon steel, ASTM A 663, Grade 80.

2. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, and as shown.
   a. Polyurethane foam strip saturated with polybutylene waterproofing material which when installed at a compression ratio of 2 to 1 is impermeable to water.
   b. Resilient to -40°F with 100 percent movement recovery.
   c. Elongation of 140 percent with a tensile strength of not less than 53 pounds per square inch.
   d. Product and Manufacturer:
      1) Polytite Standard by Polytite Manufacturing Corporation.
      2) Or equal.

3. Masonry Control Joint Components:
   a. Neoprene Bellows-Type Joint Strips: Bellows-type strip made from 1/16-inch cured, calendered neoprene with perforated flanges.
      1) Product and Manufacturer: Provide one of the following:
         a) Expand-O-Gard WS by Schuller International, Incorporated.
         b) Or equal.
   b. Premolded Control Joint Strips: Provide complete selection of solid extruded rubber strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D 2240, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
      1) Product and Manufacturer:
         a) #RS Series - Rubber Control Joints by Hohmann & Barnard, Incorporated.
         b) Or equal.
   c. Sealants: Refer to Section 07 92 00, Calking and Sealants.

4. Cavity Fill Mesh:
   a. Monofilament screen of polypropylene polymers 1/4-inch mesh hardware cloth. Install below all block courses that are to be filled with mortar.
   b. Product and Manufacturer:
      1) #MGS - Mortar/Grout Screen by Hohmann & Barnard, Incorporated.
      2) Or equal.

2.2 FABRICATION

A. Weld-in-place all channel slots and other specified weld-on anchors at the shop. Field welding is not acceptable.

B. Prime all weld-on anchors and other accessories and passivate anchor coating as required and specified under Section 09 90 00, Painting.

C. Shop-fabricate reinforcing bars which are shown or required to be bent or hooked. Comply with the requirements of ACI 315 for the fabrication of reinforcing steel for unit masonry construction Work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 04 20 00, Unit Masonry Construction.

+ + END OF SECTION + +

SECTION 04 20 00

UNIT MASONRY CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all unit masonry construction. The Work also includes:
      a. Providing openings in unit masonry construction to accommodate the Work under this and other Sections and building into the unit masonry construction all items such as sleeves, anchor bolts, inserts and all other items to be embedded in unit masonry construction for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the unit masonry construction.
   2. Unit masonry construction advanced without built-in flashings and other built-in items shall be removed and rebuilt at no additional expense to OWNER, even if discovered after unit masonry construction has been completed.

1.2 QUALITY ASSURANCE

A. Comply with the applicable requirements of the Phoenix Building Code for the types of unit masonry construction Work shown.

B. Construction Tolerances:
   1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4-inch in 10 feet, or 3/8-inch in a story height or 20 feet maximum, nor 1/2-inch in 40 feet or more. Except for external corners, expansion joints and other conspicuous lines, do not exceed 1/4-inch in any story or 20 feet maximum, or 1/2-inch in 40 feet or more.
   2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
   3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed 1/2-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
   4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4-inch nor plus 1/2-inch.

C. Mock-up:
   1. Prior to installation of unit masonry construction, but after ENGINEER'S approval of samples, erect mock-up using materials, pattern bond and joint tooling shown or specified for the Work. Provide special features as directed including finished opening 1 foot-4 inches by 1 foot-4 inches, finished end, and masonry control joint. Build mock-up at the site, in location approved by

ENGINEER, of full required wall thickness and approximately 4 feet - 0 inches by 3 feet - 4 inches, unless another size or location is shown as the portion of wall required to be constructed as mock-up. Indicate the proposed range of color, texture, and workmanship to be expected in the completed Work. Obtain ENGINEER'S acceptance of visual qualities of the mock-up before start of unit masonry construction. Retain and protect mock-up during construction as a standard for judging completed unit masonry construction. Do not alter, move, or destroy mock-up until given written permission by ENGINEER.

2. Build as many mock-up panels as required to obtain ENGINEER'S acceptance of the Work.
3. Masonry construction that does not meet the standards approved on mock-up panel shall be removed and rebuilt as required by ENGINEER.

D. Pre-Installation Meeting:
   1. Prior to the installation of unit masonry construction, CONTRACTOR and CONTRACTOR'S installer are to attend a Pre-Installation Meeting at the site. Review foreseeable methods and procedures related to the unit masonry construction including, but not necessarily limited to, the following:
      a. Project requirements, including the Contract Documents.
      b. Structural concept.
      c. Method of sequence of masonry construction.
      d. Special masonry details.
      e. Required submittals, both completed and yet to be completed.
      f. Standard of workmanship.
      g. Quality control requirements.
      h. Job organization and availability of materials, tradesmen, equipment, and facilities needed to make progress and avoid delays.
      i. Masonry control and expansion joint location and materials.
      j. Modular planning requirements.
      k. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
      l. Required inspection, testing and certifying procedures.
      m. Regulations concerning building code compliance.
   2. Attendance is mandatory for the following:
      a. CONTRACTOR'S superintendent.
      b. Masonry subcontractor's superintendent.
      c. Masonry subcontractor's foreman.
      d. Authorized representative of concrete unit masonry supplier.
      e. ENGINEER'S authorized representative.
   3. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.
   4. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. TMS 402/602-16 Building Code Requirements and Specification for Masonry Structures
   2. National Concrete Masonry Association, "TEK Manual for Concrete Masonry Design and Construction."
   3. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Complete layout of all masonry walls showing modular planning and all special shapes to be used in the Work. Show all details for each condition encountered in the Work. Provide plan and elevation views drawn at 1/4-inch scale and details drawn at 1-1/2-inch scale. Show all items required to be built into unit masonry construction.
   2. Masonry control joint locations and details.
   3. Drawings showing the location, extent and accurate configuration and profile of all items shown, specified, and required by this and other Sections to be built into the unit masonry construction as the Work progresses. Provide elevations drawn at 1/4-inch scale and all details drawn at 1-1/2-inch scale.
   4. Drawings for fabrication, bending, and placement of reinforcing bars. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcing for unit masonry construction.
   5. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedure.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver reinforcing to the site, bundled, tagged, and marked. Use metal tags indicating size, lengths and other markings shown on approved Shop Drawings. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage and Handling of Materials:
   1. Protect masonry materials during storage and construction from wetting by rain, ground water and from soilage or intermixture with earth or other materials. Use a properly erected shelter.
   2. Maintain temperatures in shelter so that masonry materials are above 20°F when laid.
   3. Handle materials in a manner that minimizes chips, cracks, voids, discolorations or other defects, which might be visible, or cause staining in the finished Work.
   4. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

1.5 JOB CONDITIONS

A. Site Facilities: Supplemental heat sources, as may be required should CONTRACTOR wish to continue unit masonry construction in cold weather, are not available at the site. The provision of all supplemental heat energy sources and equipment is the responsibility of CONTRACTOR.

B. Environmental Requirements:
   1. Do not erect any unit masonry construction when air temperature is below 28°F on a rising temperature or below 36°F on a falling temperature without temporary heated enclosures or without heating materials or other precautions necessary to prevent freezing as specified in Paragraph 1.5.C., below.

2. Do not use frozen materials. Do not build upon frozen unit masonry construction.
3. Remove and replace all unit masonry construction damaged by frost or freezing.

C. Protection:
1. Protect all unit masonry construction against freezing for at least 48 hours after being placed.
   a. Mean Daily Air Temperature 40°F to 32°F: Protect unit masonry construction from rain for 48 hours after installation.
   b. Mean Daily Air Temperature 32°F to 25°F: Completely cover unit masonry construction for 48 hours after erection.
   c. Mean Daily Temperature 25°F to 20°F: Completely cover unit masonry construction with insulating blankets for 48 hours.
   d. Mean Daily Air Temperature 20°F and Below: Maintain unit masonry construction above 32°F for 48 hours by enclosure and supplementary heat.
2. When Work is not in progress, protect partially completed unit masonry construction against rapid heat loss and from water entering masonry, by covering top of walls with strong, waterproof, nonstaining membrane. Extend membrane at least two feet down both sides of walls and secure in place using wall cover clamps spaced at intervals of 4 feet-0 inches, and at each end and joint of covering.
3. Do not apply floor or roof loading for at least three days after completing masonry columns or walls.
4. Do not apply concentrated loads for at least seven days after completing masonry walls.

D. Cold Weather Unit Masonry Construction:
1. All mortar for use in unit masonry construction when the mean daily temperature is below 40°F shall be Portland cement-lime-sand mortars using high early strength Portland cement.
3. Air Temperature 40°F to 32°F: Heat sand or mixing water to minimum of 70°F and maximum of 160°F.
4. Air Temperature 32°F to 25°F: Heat sand and mixing water to minimum of 70°F and maximum of 160°F.
5. Air Temperature 25°F to 20°F: Heat sand and mixing water to minimum of 70°F and maximum of 160°F. Provide heat on both sides of wall under construction. Employ wind breaks when wind is in excess of 15 mph.
6. Air Temperature 20°F and Below: Heat sand and mixing water to minimum of 70°F and maximum of 160°F. Provide enclosure and auxiliary heat to maintain air temperature above 32°F. Temperature of masonry units when laid shall not be less than 20°F.

E. Hot Weather Unit Masonry Construction: Protect unit masonry construction by methods acceptable to ENGINEER, from direct exposure to wind and sun when the surrounding air temperature is 99°F in the shade with relative humidity less than 50 percent.

PART 2 – NOT USED

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which unit masonry construction is to be installed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Wetting of Masonry Units:
   1. Glazed Structural Tile: Wet units that display an absorption rate of 12 percent or more when immersed for one hour in boiling water.
   2. Use wetting methods, which ensure that each masonry unit is nearly saturated, but surface dry when laid.
   3. Except for absorbent units specified to be wetted, lay masonry units dry. Do not wet concrete masonry units.

B. Cleaning Reinforcement: Before being placed, remove all loose rust, mill scale, earth, ice and other contamination from reinforcement. Do not use reinforcing bars with kinks or bends not shown on Drawings or approved Shop Drawings, or bars with reduced cross-section due to excessive rusting or other causes.

3.3 INSTALLATION, GENERAL

A. Thickness: Build walls, floors and other unit masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness shown or specified.

B. Build chases and recesses as shown or required by others. Refer to Paragraph 1.1.B., herein, for the requirements of coordination with others. Provide not less than 8- inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to starting of unit masonry construction. After installation of said items, complete unit masonry construction to match Work immediately adjacent to openings.

D. Cut masonry units using motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full size units without cutting wherever possible. Provide special unit masonry shapes for all transitions and intersections. Do not attempt to field-cut special shapes from regular unit masonry shapes or to substitute other alternatives for the use of special unit masonry shapes.

E. Matching Existing Masonry Work: Match coursing, pattern bond, color and texture of new unit masonry construction with existing work.

3.4 LAYING MASONRY WALLS

A. General:
   1. Mortar Types: Unless otherwise indicated, use mortar as specified in Section 04 05 13, Mortar and Masonry Grout, and as follows:
      a. Use Type S mortar for all exterior and all load-bearing walls.
      b. Use grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction.
      c. Do not use mortar, which has begun to set, or if more than 1/2 hour has elapsed since initial mixing. Retemper mortar during the 1/2-hour period only as required to restore workability.
   2. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns and offsets. Avoid the use of less than half size units at corners, jambs and wherever possible at other locations.
   3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced and coordinated with other work.
   4. Pattern Bond:
      a. Lay all concrete unit masonry in running bond pattern with vertical joints in each course centered on units in courses above and below. Avoid the use of less than full size units.
      b. Lay all concrete unit masonry scheduled or shown to be concealed by finish materials, except paint, with all units in a wythe bonded by lapping not less than 2-inches.
      c. Bond and interlock each course of each wythe at corners.
      d. Do not use units with less than 8-inch horizontal face dimensions.

B. Mortar Bedding and Jointing:
   1. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
   2. Maintain joint widths shown except for minor variations required to maintain pattern bond alignment. If not shown lay unit masonry to provide the following joint widths:
      a. Concrete Masonry Units: 3/8-inch.
      b. Provide joints, which all match.
   3. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, except paint, unless otherwise shown.
   4. Tool exposed joints slightly concave, when mortar is "thumbprint" hard, unless otherwise required to match existing joint treatment. Rake out mortar 1/2-inch deep in preparation for application of calking or sealants where required.
   5. Concave-tool exterior joints below grade.
   6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units that have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

D. Stopping and Resuming Work: Rake back one unit masonry length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.
E. Built-in Work:

1. As the Work progresses, build in items shown, specified or required by others. Refer to Paragraph 1.1.B. herein for the requirements of coordination with others. Fill cores in one block width solidly with masonry around built-in items.
2. Fill space between hollow metal frames and masonry solidly with mortar.

F. Horizontal Joint Reinforcing:
1. Provide continuous horizontal joint reinforcing as shown and specified. Refer to Section 04 05 23, Masonry Accessories, for type of reinforcing units required. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 5/8-inch on exterior side of walls and 1/2-inch at other locations. Lap reinforcement a minimum of 6-inches at ends of units. Do not bridge masonry control joints and building expansion joints with reinforcing.
2. Reinforce all walls with continuous horizontal joint reinforcing, unless specifically noted or specified to be omitted.
3. Reinforce the following walls with continuous horizontal joint reinforcing:
   a. Single wythe walls.
4. Provide continuity at corners and wall intersections by use of prefabricated "L" sections. Cut and bend units in accordance with manufacturer's written instructions for continuity at returns, offsets, pipe enclosures and other special conditions.
5. Space continuous horizontal reinforcing as follows:
   a. For single wythe walls, space reinforcing at 16-inches on centers vertically, unless otherwise shown.
   b. For parapets, space reinforcing at 8-inches on centers vertically, unless otherwise shown.
6. Reinforce masonry openings greater than 12-inches wide with horizontal joint reinforcing placed in two horizontal joints approximately 8-inches apart, immediately above the lintel and immediately below the sill. Extend reinforcing a minimum of 24-inches beyond jambs of the opening.
7. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the above.

G. Structural Reinforced Unit Masonry Construction:
1. Comply with requirements of TMS 402/602 and the Phoenix Building Code for structural reinforced unit masonry construction.
2. Shape and dimension reinforcement as shown and required by ACI and the Phoenix Building Code.
3. Position reinforcing accurately at the spacing shown on approved Shop Drawings. Support and secure vertical bars against displacement using rebar positioners.
4. Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1-inch, whichever is greater.
5. Provide lapped splices with reinforcing steel placed in contact and wire tied. Provide minimum lap required by governing code, unless more stringent requirements are shown. Do not splice reinforcement at points other than shown or as approved on Shop Drawings.
6. Provide substantial and tight formwork and shores as required for temporary support of reinforced masonry elements. Design, erect, support, brace and maintain formwork.
7. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar grout. Brace, tie and support as

required to maintain position and shape during construction and curing of reinforced masonry.

8. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and all other temporary loads that may be placed on them during construction.
9. Allow not less than the following minimum time to elapse after completion of a member before removing shores or forms, provided suitable curing conditions have been obtained during the curing period:
   a. Masonry Foundation Slabs: Seven days.
   b. Reinforced Masonry Soffits: Seven days.

H. Grouting Structural Reinforced Unit Masonry Construction:
1. Limit extent of masonry construction to sections, which do not exceed the maximum, pour requirements specified. Provide temporary dams or barriers to control horizontal flow of grout at ends of wall sections. Build dams full height of grout pour. If masonry units are used, do not bond into permanent masonry wythes. Remove temporary dams after completion of grout pour.
2. Use fine grout for filling spaces less than 4-inches in both horizontal directions. Use coarse grout for filling spaces 4-inches or larger in both horizontal directions.
3. For spaces 10-inches and larger use concrete fill.
4. Low-Lift Grouting:
   a. Use low-lift grouting techniques using fine grout mix for the following:
      1) Two-wythe walls with grout space of 2-inches or less in width.
      2) Multi-wythe walls.
      3) Columns, piers and pilasters where masonry units are shown in core areas enclosed by masonry units.
      4) Grout spaces less than 2-inches in width at intervals not to exceed 24-inches in lifts of 6 to 8-inches.
      5) At CONTRACTOR'S option, low-lift grouting technique may be used for structural reinforced unit masonry construction with grout spaces wider than 2-inches, except use coarse grout mix and place in lifts not to exceed 8-inches in height.
   b. Construct low-lift structural reinforced unit masonry construction by placing reinforcing, laying masonry units and pouring grout as the Work progresses.
   c. Place vertical reinforcing bars and supports prior to laying of masonry units. Extend above elevation of maximum pour height as required to allow for splicing. Horizontal reinforcing bars may be placed progressively with laying of masonry units.
   d. Limit grout pours as required to prevent displacement of masonry by grout pressure (blowout), but do not exceed 12-inch pour height.
   e. Lay masonry units prior to each grout pour, but do not construct more than 12-inches above maximum grout pour height in one exterior wythe and 4-inches above in other exterior wythe. Provide metal wall ties, if required, to prevent blowouts.
   f. Pour grout using container with spout and consolidate immediately by rodding or puddling; do not use trowels. Place grout continuously; do not interrupt pouring of grout for more than one hour. If poured in lifts, place from center-to-center of masonry courses. Terminate pour 1-1/2 inches below top of highest course in pour.

L. Anchoring Masonry Work:
   1. Provide anchoring devices of the type specified under Section 04 05 23, Masonry Accessories. If not shown or specified, provide standard type for facing and back-up involved in compliance with requirements of the Phoenix Building Code.
   2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
      a. Provide an open space not less than 1/2-inch or more than 1-inch in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar and other rigid materials.
      b. Space anchors as shown, but not more than 24-inches on center vertically and 36-inches on center horizontally.
      c. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, fire safing insulation, backer rod and sealant.

M. Masonry Control and Expansion Joints:
   1. Provide vertical expansion, and control joints in masonry where shown. Build in related items as the unit masonry construction progresses. Rake out mortar in preparation for application of calking and sealants. Refer to Section 07 92 00, Calking and Sealants.
   2. Provide masonry control joints items specified under Section 04 05 23, Masonry Accessories, where masonry control joints are shown.
      a. Build flanges of metal expansion strips into masonry. Lap each joint 4-inches in direction of flow. Solder joints below grade.
      b. Build flanges of factory-fabricated bellows-type joint strips into masonry.
      c. Build in compressible fillers as specified. Install in accordance with manufacturer's written instructions.
      d. Build in factory-premolded control joint strips into masonry. Build in sash block and premolded control joint strips as the Work progresses.
      e. Provide end blocks where masonry partitions abut structure to facilitate installation of compressible filler, fire safing insulation, backer rod and sealant.
   3. Masonry Control Joint Spacing: Locate masonry control joints as shown.

N. Lintels and Bond Beams:
   2. Provide masonry lintels and bond beams where shown and wherever openings of 16-inches or more are shown without structural steel lintels. Provide formed in place masonry lintels and bond beams. Temporarily support formed-in-place lintels and bond beams.
      a. Unless otherwise shown, provide one horizontal No. 6 deformed reinforcing bar for each 4-inches of wall thickness.
      b. For hollow masonry unit walls, use specially formed "U" shaped lintel and bond beam units with reinforcing bars placed as shown, filled with grout as specified in Section 04 05 13, Mortar and Masonry Grout.
   3. Provide minimum bearing at each jamb, of 4-inches for openings less than 6 feet - 0 inches wide, and 8-inches for wider openings.
   4. On concrete unit masonry walls where pattern bond remains visually exposed, increase minimum bearing of masonry lintels to maintain joint pattern of wall and install so as to be indistinguishable from surrounding masonry.

3.5 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings and adjacent Work to provide a neat, uniform appearance, properly prepared for application of sealant compounds.

C. Cleaning Exposed, Masonry Surfaces:
   1. Wipe off excess mortar as the Work progresses. Dry brush at the end of each day's work.
   2. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain ENGINEER'S acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
      a. Dry clean to remove large particles of mortar using wood paddles and scrappers. Use chisel or wire brush if required.
      b. Presoak wall by saturating with water and flush off loose mortar and dirt.
      c. Scrub down wall with stiff fiber brush and a solution of 1/2 cup of sodium hexameta phosphate and 1/2 cup of household detergent dissolved in one gallon of water.
      d. Rinse walls, using clean, pressurized water, to neutralize cleaning solution and remove loose material.
      e. Acid cleaning of masonry will not be permitted.
   3. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain ENGINEER'S acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
      a. Dry clean to remove large particles of mortar using wood paddles and scrappers. Use chisel or wire brush if required.
      b. Presoak wall by saturating with water and flush off loose mortar and dirt.
      c. Apply acid-type cleaners in compliance with manufacturer's instructions.
      d. Protect other Work from acid solutions and cleaning operations.

D. Protection:
   1. Protect the unit masonry construction from deterioration, discoloration or damage during subsequent construction operations.

+ + END OF SECTION + +

SECTION 04 22 00

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish concrete masonry units.
   2. Extent of each type of concrete masonry units is shown on the Drawings.
   3. Types of products and features required include the following:
      a. Hollow non-load bearing units.
      b. Solid load bearing units.
      c. Integral waterproofing admixtures, high recycle content, special and custom shapes as required to complete the Work, complete selection of manufacturer's standard and custom colors and other special and custom features.

1.2 QUALITY ASSURANCE

A. Performance Requirements:
   1. Limit total moisture absorption until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the United States Weather Bureau Station nearest the site and the corresponding percentage of total linear drying shrinkage of the concrete masonry units.
   2. Comply with ASTM C 90 Climatic Map establishing criteria for percent annual mean relative humidity.

B. Allowable Tolerances: For concrete masonry units provide the following:
   1. Face Dimension: The total variation in the finished and installed face dimensions of the units shall be not more than 1/16-inch between the largest and smallest units in any lot of each size.
   2. Top and Bottom Surfaces: Ground to provide finish height of 7-5/8-inches ±1/16-inch.
   3. Hand Sort and Match Concrete Units: Concrete masonry units, which exceed these, specified allowable tolerances shall be rejected for use in the Work. Concrete masonry units inadvertently installed in the Work, which exceed the allowable tolerances specified, shall be removed and new units installed.

C. Comply with applicable requirements of the Phoenix Building Code for types of concrete masonry shown or specified.

D. Source Quality Control:
   1. Obtain each type of concrete masonry units from one manufacturer, cured by one process and of uniform texture and color or in an established uniform blend thereof.

2. Provide test data verifying total linear drying shrinkage based on tests of concrete masonry units made with the same materials, concrete mix proportions, manufacturing process, and curing method, conducted in compliance with ASTM C 426, not more than 24 months prior to delivery.
3. Cure units by autoclave treatment at minimum temperature of 350°F, and a minimum pressure of 125 pounds per square inch.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM C 33, Specification for Concrete Aggregates.
2. ASTM C 90, Specification for Load bearing Concrete Masonry Units.
3. ASTM C 129, Specification for Nonloadbearing Concrete Masonry Units.
4. ASTM C 140, Test Methods for Sampling and Testing Concrete Masonry Units.
5. ASTM C 426, Test Method for Drying Shrinkage of Concrete Masonry Units.
6. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
7. ASTM E 119, Test Methods for Fire Tests of Building Construction and Materials.
8. UL Design Numbers U901 through U908.
9. Phoenix Building Code.

1.3 SUBMITTALS

A. Samples:
1. Each type of concrete masonry unit specified. Select each type of concrete masonry unit to show the range of color and texture that can be expected in the finished Work.
2. Complete selection of manufacturer’s standard and custom colors.
3. ENGINEER'S review will be for color and texture only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings:
1. Copies of manufacturer's specifications, manufacturing procedures and test data for each product specified, including certification that each product complies with the specified requirements. Include instructions for handling, storage, installation, and protection of each type of concrete masonry unit.
2. Complete layout of all masonry walls showing modular planning, colors, patterns, and all special shapes to be used in the Work. Show all details for each condition encountered in the Work. Provide plans and elevation at 1/4-inch scale and details at 1-1/2-inch scale.
3. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

C. Certifications: Provide written certification to ENGINEER that concrete masonry units have been manufactured using only licensing manufacturer's approved materials, manufacturing methods, product standards and in compliance with the applicable ASTM standard.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver concrete masonry units in original, unopened, and undamaged packages and pallets, plainly marked with identification of materials and name of approved manufacturer. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.
2. Provide units delivered by the manufacturer or manufacturer's agent. At time of unloading, units shall conform to the requirements prescribed in ASTM C 90, Table 1 - Moisture Content Requirements for Type I Units.

B. Storage of Materials: Store materials off the ground, protected from dirt, construction traffic and contamination. Cover concrete masonry units to prevent damage such as chipping, wetting, and staining. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL, CONCRETE MASONRY UNITS

A. General: Unless specifically modified by other requirements specified, provide concrete masonry units in compliance with the following classifications, weights, grades, colors, textures, scores, thermal resistance values and other features specified.

B. Hollow and Solid Loadbearing Concrete Masonry Units: ASTM C 90, Type I, Moisture-Controlled Units, with a minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of the concrete mix.

C. Hollow Non-load bearing Concrete Masonry Units: ASTM C 129, Type I, Moisture-Controlled Units, with a minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of the concrete mix.

D. Size: Manufacturer's standard units with nominal face dimensions of 16-inches long by 8-inches high (15-5/8-inches by 7-5/8-inches actual).

E. Special Shapes: Provide the following:
1. Lintels, bond beams, reinforcing units, and flush-end reinforcing units, interior and exterior corner shapes, solid jambs, sash block, coves, premolded control joint blocks, headers, and other special conditions.
2. Provide square edge block for horizontal and vertical outside corners, except where shown as bullnose.
3. End blocks at all locations where masonry walls abut concrete, or steel columns to facilitate installation of compressible filler, backer rod and sealant or fire-rated fire stop sealant systems, if required.

F. Waterproofing Admixture: Manufacture all types of concrete masonry units, used in construction of exterior walls (including interior wythe of cavity walls) with an integral waterproofing admixture as follows:
1. Material: Cross-linking acrylic polymer.
2. Proportion: In strict accordance with manufacturer's instructions.
3. Product and Manufacturer: Provide one of the following:

a. DRY-BLOCK System by Forrer Industries, a Unit of W. R. Grace & Company Construction Products Division.
b. ADDIMENT Block Plus W-10 System by Addiment Incorporated.
c. Or equal.

G. Weight: Provide normal weight units using aggregate complying with ASTM C33 producing dry net weight of not more than 125 pounds per cubic foot.

H. Exposed Faces: Provide manufacturers' standard and custom colors and textures as specified for the type of concrete masonry unit.

I. Provide two-core concrete masonry units.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 04 20 00, Unit Masonry, Section 04 05 13, Masonry Mortaring, Section 04 05 23, Masonry Accessories and Section 07 21 00, Building Insulation.

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SECTION 05 12 00

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install structural steel, including surface preparation and shop priming.
   2. Structural steel is that Work defined in AISC "Code of Standard Practice", Section 2, and as shown on the Drawings. The Work also includes:
      a. Providing openings in and attachments to structural steel to accommodate the Work under this and other Sections and providing for the structural steel all items such as anchor bolts, studs and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the structural steel.

1.2 QUALITY ASSURANCE

A. Reference Standards and Codes: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. 360, Specifications for Structural Steel Buildings.
      c. Quality Certification Program for Fabricators.
   2. American Society of Mechanical Engineers (ASME):
      a. B18.21.1, Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
   3. ASTM International (ASTM):
      a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
      b. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      c. A36/A36M, Standard Specification for Carbon Structural Steel.
      d. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      e. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      f. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

i. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
j. A563, Standard Specification for Carbon and Alloy Steel Nuts.
k. A847/A847M, Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
l. A992/A992M, Standard Specification for Structural Steel Shapes.
m. A1064/A1064M, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
n. F436, Standard Specification for Hardened Steel Washers.
o. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
p. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
q. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

4. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.17/A5.17M, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   d. A5.18/A5.18M, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   e. A5.20/A5.20M, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   f. A5.23/A5.23M, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   g. A5.28/A5.28M, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   h. A5.29/A5.29M, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   i. D1.1/D1.1M, Structural Welding Code - Steel.
      1) Steel stud connectors and their installation to comply with requirements of AWS D1.1/D1.1M.
5. National Institute of Steel Detailing (NISD).
6. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints Using High-Strength Bolts.

B. Design of Members and Connections:
   1. All details shown on the Drawings are typical; similar details apply to similar conditions, unless otherwise shown on the Drawings or specified. Verify dimensions at the site without causing delay in the Work.
   2. Examine conditions under which structural steel is to be provided, and notify ENGINEER, in writing, of unsatisfactory conditions existing or whenever design of members and connections may not be clearly shown on the Drawings. Do not proceed with the Work until unsatisfactory conditions or deficiencies have been corrected in a manner acceptable to ENGINEER.

C. Source Quality Control:
   1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
   2. Fabrication shall be performed by a structural steel fabricating plant possessing a current certificate from AISC stating that the plant satisfies the requirements for certification for Category II of the AISC Quality Certification Program. The plant shall maintain this certification for the entire time fabrication for this project is being performed.

D. Qualifications for Welding Work:
   1. Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code" D1.1, Section 5, Qualification.
   2. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. Ensure that all certifications are kept current.
   3. All welds will be subject to visual inspection. Where visually deficient welds are observed, the welds will be tested using non-destructive methods by a certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, pay for testing, correct improper workmanship, remove, and replace, or correct as instructed, all welds found unacceptable or deficient. Responsibility belongs to CONTRACTOR to pay for all corrections and subsequent tests required to confirm the integrity of the weld.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing the sequence of erection.
      a. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.
      b. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
   2. Copies of manufacturer's specifications and installation instructions for products listed below. Include laboratory test reports and other data as required to show compliance with the Contract Documents.
      a. Structural steel of each type, including certified copies of mill reports covering the chemical and physical properties.
      b. High-strength bolts of each type, including nuts and washers.
      c. Unfinished bolts and nuts.
      d. Shop primer and touch-up field primer paint in accordance with Section 09 90 00, Painting.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site at such intervals to ensure uninterrupted progress of the Work.
   1. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not delay that Work.
   2. Comply with the requirements of Section 03 15 19, Anchorage in Concrete.

B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.
   2. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
   1. All W-shapes and WT-shapes: ASTM A992/A992M.
   2. All other plates, bars and rolled shapes: ASTM A36/A36M.

B. Pipe: ASTM A53/A53M, Grade B (Type E or S) (Fy=35).

C. Hollow Structural Sections (HSS):
   1. Round: ASTM A500/A500M, Grade B (Fy=42).
   2. Square or rectangular: ASTM A500/A500M, Grade B (Fy=46).

D. High-Strength Bolts, Nuts and Washers:
   1. ASTM F3125, Grade A325 with ASTM A563 nuts galvanized:
   2. High-strength bolts:
      a. Provide two ASTM F436 washers for all bolts galvanized.
      b. Provide beveled washers at connections of sloped/tapered sections.

E. Non-high Strength Bolts, Nuts and Washers:
   1. ASTM A307, Grade A.
   2. Plain washers: ASME B18.22.1, Type B.

F. Headed Stud Type Shear Connectors:
   1. Headed studs:
      a. ASTM A108, complying with AWS D1.1/D1.1M, Section 7, Type B; minimum yield strength 50,000 psi, minimum tensile strength 60,000 psi.
      b. Uniform diameter.
      c. Heads: Concentric and normal to shaft.
      d. Weld end: Chamfered and solid flux.
   2. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

G. Electrodes for Welding: E70XX complying with AWS D1.1, Design of New Buildings, Section 8. AWS D1.1.

H. Surface Preparation and Shop Priming: All structural steel shall be primed in the shop. Surface preparation and shop priming requirements are included herein, but are specified in Section 09 90 00, Painting and Coating.

I. Refer to and comply with the requirements of Section 03 60 00, Grouting, Section 05 21 00, Steel Joists, and Section 05 30 00.15, Metal Decking Roof.

2.2 FABRICATION

A. Shop Fabrication and Assembly:
   1. General:
      a. Fabricate and assemble structural assemblies in the shop to the greatest extent possible. Fabricate items of structural steel in accordance with AISC, Manual of Steel Construction, and as shown on the Shop Drawings. Provide camber in structural members as shown on the Drawings.
      b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence, which will expedite erection and minimize field handling of materials.
      c. Where finishing is required, complete the assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in the final structure free of markings, burrs, and other defects.
      d. Comply with the requirements of Section 05 50 00, Miscellaneous Metal Fabrications.

B. Connections:
   1. Shop Connections:
      a. Unless otherwise shown on the Drawings, shop connections may be welded or high strength bolted and all welds shall be 1/4-inch minimum.
      b. Shop welded connections shall be designed to eliminate or minimize eccentricity. The size, extent, location and type of all shop welds shall be clearly shown on the Shop Drawings by use of AWS standard notations and symbols.
      c. End connection angles fastened to the webs of beams and girders and the thickness of the angles, size and extent of fasteners or shop welds shall conform to tables of "Framed Beam Connections" in the AISC Manual. All connections shall be two sided, unless otherwise shown on the Drawings.
   2. Field Connections:
      a. All field connections, unless otherwise specified below or noted, shall be made with high strength bolts, and shall be bearing type connections.
      b. Common bolts may be used for beam to beam, and beam to girder connections.
      c. Field welding may be used only where noted or approved by ENGINEER.
   3. High-Strength Bolted Construction:
      a. Install high-strength threaded fasteners in accordance with RCSC.
      b. High strength bolt design shear values shall be as specified in the AISC Manual for bolts with threads in the shear plane.
      c. The minimum size of bolts shall be 3/4-inch diameter, unless otherwise noted.

4. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.
   a. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.
5. Shear Connectors: Install stud shear connectors in accordance with AWS D1.1 Section 4, and as recommended by the manufacturer.

C. Bracing:
1. Bracing, for which a calculated stress is not shown on the Drawings, shall have a minimum two bolt connection, or a shop welded connection of equivalent strength.
2. Vertical bracing and knee braces connecting to columns shall be on the centerline of the columns, unless otherwise noted.
3. Knee braces shall be at 45 degree angle, unless shown on the Drawings or noted.
4. All gussets shall be minimum 3/8-inch thick, unless otherwise shown on the Drawings.

D. Column shafts shall have "finished" bearing surfaces at the base and at all splice lines.

E. Structural HSS shall be properly sealed to protect the internal surfaces.

F. Holes and Appurtenances for Other Work:
1. Provide holes required for securing other work to structural steel framing, and for the passage of other work through steel framing members, as shown on the Shop Drawings. If large block-outs are required and approved by the Engineer, the webs shall be reinforced to develop specified shears. Provide threaded nuts welded to framing, and other specialty items as shown on the Drawings to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
3. Refer to Paragraph 1.1.B, above, for the requirements of coordination with others.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which structural steel Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 ERECTION

A. General: Comply with the AISC Specifications and Code of Standard Practice, and as herein specified.

B. Surveys: Provide services of a registered surveyor to check lines and elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar

devices before steel erection proceeds. Discrepancies shall be reported immediately to ENGINEER, in writing. Do not proceed with erection until corrections have been made, or until compensating adjustments to the structural steel Work have been agreed upon with ENGINEER.

C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.

D. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with OSHA requirement of a tightly planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which Work is performed.

E. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place Work.
   1. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.
      a. Refer to Section 03 15 19, Anchorage in Concrete , of these Specifications for anchor bolt installation requirements.

F. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.
   1. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.
   2. Tighten the anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout.
   3. Place grout between bearing surfaces and bases or plates as specified in Section 03 60 00, Grouting. Finish exposed surfaces, protect installed materials, and allow curing in strict compliance with the manufacturer's instructions, or as otherwise required.
   4. Leveling plates and wood wedges will not be permitted.

G. Field Assembly: Set structural frames accurately to the lines and elevations as shown on the Drawings. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces, which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of the structure within tolerances as specified in AISC Manual. For members requiring accurate alignment, clip angles, lintels and other members shall be provided with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
   2. Splice members only where shown on the Drawings or specified.

H. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

I. Comply with AISC Manual for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
   1. Do not enlarge unfair holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

J. Gas Cutting: Do not use gas cutting torches for correcting fabrication errors in the structural framing. Cutting will be permitted only on secondary members, which are not under stress, as acceptable to ENGINEER. Finish gas-cut sections equal to a sheared appearance when permitted.

K. Touch-Up Painting:
   1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 09 90 00, Painting and Coating.
   2. Immediately after erection, clean field welds, bolted connections, and all damaged and abraded areas of the shop paint. Apply paint to all exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness as specified in Section 09 90 00, Painting and Coating.

3.3 FIELD QUALITY CONTROL

A. Engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
   1. The testing agency shall conduct and interpret the tests and state in each report whether the test specimens comply with the requirements, and specifically state all deviations.
   2. Provide access for the testing agency to places where structural steel Work is being fabricated or produced so that required inspection and testing can be accomplished.
   3. The testing agency may inspect structural steel at the plant before shipment; however, ENGINEER reserves the right, at any time before Final Acceptance, to reject material not complying with specified requirements.

B. Correct deficiencies in structural steel Work that inspection and laboratory test reports indicate do not comply with the Specifications. Perform additional tests, as may be required to reconfirm any non-compliance of the original Work, and as may be required to show compliance of corrected Work.

+ + END OF SECTION + +

SECTION 05 21 00

STEEL JOISTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install steel joists.
   2. The extent of steel joists is shown on the Drawings, including basic layout.
   3. The types of joists required are as follows:
      a. K-Series Open Web Steel Joists.
   4. The Work also includes:
      a. Providing attachments to steel joists to accommodate the Work under this and other Sections and providing for the steel joists all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the steel joists.
   2. Design all open web steel joists for a 2,000 lb load at mid span. The 2,000 lb load can be in place of the distributed live load. The load shall be applied to the bottom chord of the joist, and is in addition to all other loads.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as shown or specified.
   1. American Institute of Steel Construction (AISC):
      a. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      c. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      d. F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
      e. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
   4. Corps of Engineers (COE):
      a. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink).
   5. Steel Joist Institute (SJI):

a. Recommended Code of Standard Practice for Steel Joists and Joist Girders.
b. Standard Specification for Open Web Steel Joists, K-Series (ANSI SJI-K-1.1).
c. Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders:
1) Standard Load Table Open Web Steel Joists, K-Series.

B. Qualifications for Welding Work:
1. Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code" D1.1, Section 5, Qualification.
2. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. Ensure that all certifications are kept current.
3. All welds will be subject to visual inspection. Where visually deficient welds are observed, the welds will be tested using non-destructive methods by a certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, testing costs belong to CONTRACTOR. Responsibility also belongs to CONTRACTOR to correct improper workmanship, remove, and replace, or correct as instructed, all welds found unacceptable or deficient, and to pay for all corrections and subsequent tests required to confirm the integrity of the weld.

C. Fabricator Qualifications: Fabricated by a firm regularly engaged in the manufacture of the types of steel joist specified. Manufacturer to have fabricated joists for at least two years.

1.3 SUBMITTALS

A. Shop Drawings:
1. Fabrication and/or layout drawings, signed by a professional engineer:
a. Detailed Shop Drawings showing size and layout of each joist unit, bridging, connections, and accessories. Include mark, number, type, location, and spacing of joists and bridging.
b. Show joining splice and connection to other work details.
c. Provide templates or location drawings for installation of anchor bolts.
d. Provide details of bridging, method of attachment to joists, and joist end anchorage and other details required for joist installation. Indicate beveled end plates for joist roof pitch where required.
e. Show shop-applied coatings.
f. Shop Drawings shall not be reproductions of the Contract Drawings.
2. Product technical data including:
a. Joist manufacturer's load tables, Standard Specifications, and installation instructions for each type of joist and its accessories. Include product data describing materials, shop coating, bridging, and accessories.
3. Certifications:
a. Manufacturer's certification that steel joists and accessories comply with specified requirements.
b. Manufacturer member of SJI.
c. Joist material, shop welding and testing, manufacturing and shop inspection and testing are in accordance with SJI requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle steel joists as recommended by SJI Specifications. Handle and store joists in a manner to avoid deforming members and to avoid excessive stresses.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel: Comply with SJI and AISC Specifications for joists series indicated.

B. Unfinished Threaded Fasteners: ASTM A 307, Grade A, regular hexagon type, low carbon steel.

C. High-Strength Threaded Fasteners: ASTM F3125, Grade A325 or ASTM A 490 heavy hexagon structural bolts with nuts and hardened washers.

D. Surface Preparation and Shop Priming: All steel joists shall be primed in the shop. Surface preparation and shop priming requirements are included herein, but are specified in Section 09 90 00, Painting and Coating.

2.2 FABRICATION

A. General: Fabricate steel joists in accordance with SJI Specifications.

B. Bottom Chord: Joists with bottom chords consisting of round bars will not be acceptable.

C. Holes in Chord Members:
   1. Provide holes in chord members where shown on the Drawings for securing other work to the steel joists.

D. Extended Ends:
   1. Provide extended ends on joists where shown on the Drawings, complying with the manufacturer's standards and requirements of applicable SJI Specifications and load tables.

E. Bridging:
   1. Provide horizontal or diagonal type bridging for open web joists, complying with SJI Specifications.

F. End Anchorage: Provide end anchorages to secure joists to adjacent construction, complying with SJI Specifications, unless otherwise shown on the Drawings.

G. Header Units: Provide header units to support interrupted open web joists at openings in floor or roof system not framed with steel shapes.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 ERECTION

A. Place and secure steel joists in accordance with SJI Specifications, approved Shop Drawings, manufacturer's recommendations and as specified.

B. Anchor Bolts:
   1. Furnish anchor bolts and other devices to be built into the concrete and masonry construction. Furnish templates for the accurate location of anchors in other Work.
      a. Furnish unfinished threaded fasteners for anchor bolts, unless otherwise indicated.
      b. Refer to Section 03 15 19, Anchorage in Concrete.

C. Placing Joists:
   1. Do not start placement of steel joists until supporting Work is in place and secured. Place joists on supporting Work, adjust and align in accurate locations and spacing before permanently fastening.
   2. Provide temporary bridging, connections, and anchors to ensure lateral stability during construction.

D. Bridging:
   1. Install bridging simultaneously with joist erection.

E. Fastening Joists:
   1. Field weld joists to supporting steel framework in accordance with SJI Specifications for the type of joists used. Coordinate welding sequence and procedure with the placing of joists.
   2. Bolt joists to supporting steel framework in accordance with SJI Specifications for the type of joists used.
      a. Provide unfinished threaded fasteners for bolted connections, unless otherwise indicated.
      b. Provide unfinished threaded fasteners for bolted connections, except where high-strength bolts or welded connections are shown on the Drawings.
      c. Provide high-strength threaded fasteners for bolted connections of steel joists to steel columns, and at other locations where shown on the Drawings, installed in accordance with AISC, Specifications for Structural Joints Using ASTM F3125 Bolts.

F. Touch-Up Painting:

1. Unless otherwise specified below, comply with the requirements of touch-up painting specified in Section 09 90 00, Painting and Coating.
2. After joist installation, paint all field bolt heads and nuts, and welded areas, abraded or rusty surfaces on joists and steel supporting members. Wire brush surfaces and clean with solvent before painting. Apply paint to exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness as specified in Section 09 90 00, Painting and Coating.

+ + END OF SECTION + +

SECTION 05 30 00.15

METAL DECKING ROOF

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals required to furnish and install galvanized metal roof decking, as shown on the Drawings and specified.
   2. Metal roof decking work shall include roof sump pans, cant strips, ridge and valley plates, and metal closure strips. The Work also includes:
      a. Cutting and flashing of openings to accommodate the Work under this and other Sections, and providing for the metal roof decking all items required for which provision is not specifically included under other Sections.
   3. Finish painting shall be as specified in Section 09 90 00, Painting and Coating.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the metal roof decking.

1.2 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of five years of experience in the production of substantially similar roof decking, and shall be able to show evidence of satisfactory operation in at least five installations.

B. Reference Standards and Codes: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. AISI S100, Specification for the Design of Cold-Formed Steel Structural Members.
   2. AWS D1.1, Structural Welding Code.
   3. SDI, Steel Roof Deck Design Manual.
   4. ASTM A 36, Specification for Carbon Structural Steel.
   5. ASTM A 653, Specification for Steel Sheet, Zinc-Coated or Zinc-Iron Alloy – Coated by the Hot-Dip Process.
   6. ASTM A 924, Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   7. MIL-P-21035, (Ships) Paint, High Zinc Dust Content, Galvanizing Repair.

C. Unless otherwise specified or shown on the Drawings on the Drawings, design, fabrication and erection shall be in accordance with the current edition of the American Iron and Steel Institute's "Light Gauge Steel Design Specification." Steel decking shall be delivered, stored, handled and installed in such a manner that it will not be damaged or deformed.

D. Design of Decking and Connections:

1. All details shown are typical; similar details apply to similar conditions, unless otherwise shown on the Drawings or specified. Verify dimensions at the site without causing delay in the Work.

E. Qualifications for Welding Work:
   1. Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code" D1.1, Section 5, Qualification.
   2. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. Ensure that all certifications are kept current.
   3. All welds will be subject to visual inspection. Where visually deficient welds are observed, the welds will be tested using non-destructive methods by a certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, testing costs belong to CONTRACTOR. Responsibility also belongs to CONTRACTOR to correct improper workmanship, remove and replace, or correct as instructed, all welds found unacceptable or deficient, and to pay for all corrections and subsequent tests required to confirm the integrity of the weld.

1.3 PERFORMANCE REQUIREMENTS

A. Compute the properties of metal roof deck sections on the basis of the effective design width as limited by the provisions of the AISI Specifications. Provide not less than the deck section properties shown on the Drawings, including section modulus and moment of inertia per foot of width.

B. Allowable Deflection: Design and fabricate deck for a maximum deflection of 1/240 of the clear span under the total uniform dead and live load.

1.4 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Shop Drawings showing layout of deck panels, anchorage details and every condition requiring closure panels, supplementary framing, special jointing or other accessories.
   2. Submit complete erection drawings, including type of decking section, adaptations around openings and other special conditions, method of welding sections to supporting structural steel, procedure for attaching end closure plates and butt joint cover plates, and miscellaneous flashing.
   3. Where the steel beams or decking are to support loads, framing, hangers or any other items affecting design and detailing of connections, CONTRACTOR shall obtain Shop Drawings from all subcontractors, review these Shop Drawings, coordinate all interrelated work and submit a complete combined submittal to the ENGINEER for written approval prior to the start of the metal roof decking Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Galvanized Steel Sheet: ASTM A 446, Grade C. Before forming, the steel shall receive a protective metal coating of zinc conforming to ASTM A 653, with a minimum of 0.5-ounce zinc per square foot. The decking shall be 20-gauge, unless otherwise shown on the Drawings.

B. Deck sections shall be as shown on the Drawings. Decking having cross-sectional properties, which differ from the indicated, may be used provided that the structural properties of the proposed decking, are equal to or greater than, the structural properties of the decking indicated. The diaphragm shear values established by testing shall be equal to shear values established for the decking indicated.

C. Decking, where shown on the Drawings, shall have sheet lengths that cover three or more spans wherever practicable.

D. Accessories shall be formed of the same material as used for the steel deck.

E. Miscellaneous Steel Shapes: ASTM A 36.

F. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Military Specifications MIL-P-21035.

G. Flexible Closure Strips for Deck: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.

H. Product and Manufacturer: Provide one of the following:
   1. Vulcraft.
   2. Verco Manufacturing.
   3. Or equal.

2.2 FABRICATION

A. General: Form deck units in lengths to span three or more supports with flush, telescoped or nested 2-inch end laps and nesting side laps, unless otherwise shown on the Drawings. Provide deck configurations complying with SDI "Basic Design Specifications", and as specified herein.

B. Wide-Rib Deck: Depth approximately 1-1/2-inches; ribs spaced approximately 6-inches on center; width of rib opening at roof surface not more than 2-1/2-inches; width of bottom rib surface not less than 1-3/4-inches.

C. Cant Strips:
   1. Fabricate cant strips of not less than 20 gage galvanized sheet steel of the same quality as the deck units. Bend cant strips to form a 45 degree cant not less than 5-inches wide, with top and bottom flanges not less than 2-inches wide, unless otherwise shown on the Drawings. Provide cant strips in ten-foot lengths, where possible.

D. Metal Closure Strips:

1. Fabricate metal closure strips of not less than 20 gage galvanized sheet steel of the same quality as the deck units. Form to the configuration required to provide tight-fitting closures at open ends and sides of decking.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which decking is to be installed, and notify ENGINEER, in writing, of unsatisfactory conditions existing or whenever design of decking and connections may not be clearly indicated. Do not proceed with the Work until unsatisfactory conditions or deficiencies have been corrected in a manner acceptable to ENGINEER.

3.2 WORKMANSHIP

A. Prior to commencement of any Work, the decking manufacturer shall furnish an affidavit certifying to the yield strength, unit design stress and gauge of the metal, which will be used for the decking fabrication, and test-established diaphragm shear values for the decking supplied using indicated connections.

B. Metal roof decking shall be installed according to the manufacturer's recommendations. The decking manufacturer's recommendations, as approved by the Engineer, are hereby made a part of the Contract Documents.

C. Failure to conform to this requirement shall be ample justification for rejection of the material.

D. Steel decking shall be provided complete, including all cutting, shaping, fitting, drilling, welding, ridge plates, valley plates, reinforcing plates for all openings in the deck and miscellaneous pieces necessary for proper installation and weathertight construction.

E. Special care shall be exercised not to damage or overload the decking during installation. The maximum uniform distribution load shall not exceed 20 psf. The decking shall not be used for storage or as a working platform until the sheets have been welded into position. Decking stored at the site before erection shall be stacked on platforms or pallets and covered with tarpaulins or other suitable weathertight covering.

F. Deck units shall not be placed on supporting members until all connections are completed and the supporting assembly has its final design strength and capacity.

G. Decking shall be installed in a continuous operation to avoid delays in the construction.

H. The steel deck units shall be placed on the supporting framework, aligned, and adjusted to final position before being permanently fastened.

I. If the supporting beams are not properly aligned or sufficiently level to permit proper bearing of steel units, take corrective action to ensure properly aligned Work.

J. The decking sheet shall be formed at the longitudinal sides in such a manner that they will overlap and/or interlock. All interlocking seams shall be button punched at 12-inches on center, unless shown otherwise on the Drawings. End laps shall occur over bearings only.

K. Where the end of sheets overlap, they shall be die-formed in such manner that the sheet in the next row telescopes and snugly overlaps the sheet laid previously; end overlaps at bearings shall not be less than 2-inches. Sheets that abut at supports without overlapping may be provided, in which case, steel underlapping die-formed sleeves, having a minimum width of 2-inches, shall be provided to connect the abutting sheets. Where the ends of the decking sheets abut without overlapping at the supports, each end of the decking sheets shall have a minimum bearing of 3-inches on the supports and shall be welded to the supports as the underlapping sleeve connectors are installed.

L. The steel decking shall provide a continuous uniform slope, with practically flush top surfaces, and shall be installed in straight and continuous rows, as far as practicable, with ribs at right angles to the supporting members.

M. All sheets shall be 36-inches wide. Narrower closure strips shall not be less than 18-inches wide and shall be welded to adjacent full sheet with 1-inch long seam welds at 12-inches on center.

N. Flashing: Provide zinc coated continuous flashing for deck units at openings and at deck perimeters, if necessary.

O. Connection Plates: Provide 14-gauge galvanized bent plate sections as shown on the Drawings or required over perimeter and interior framing to allow specified welding to parallel supports.

P. After erection, all damaged surfaces shall be primed with a zinc dust type primer paint.

Q. All Work not in conformance with these Specifications and/or generally accepted standards of the trade shall be deemed defective by the ENGINEER and shall be rejected. All Work, which is defective, shall be corrected or replaced as directed by the ENGINEER. Corrections, redesign, and replacement of defective Work shall be at CONTRACTOR'S expense.

R. After erection, all surfaces shall be cleaned and left free of all grime and dirt. Decking shall be cleaned with solvents, if necessary, to provide a surface which will readily bond with concrete fill. Remove unused materials, tools, scaffolding, and debris from the premises, and leave the area broom clean.

3.3 INSTALLATION

A. General:
   1. Install roof deck units and accessories in accordance with manufacturer's recommendations and approved Shop Drawings, and as specified herein.

B. Placing Roof Deck Units:
   1. Place roof deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened. Lap ends not less than 2-inches. Do not stretch or contract the side-lap interlocks. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
      a. Do not place deck units on concrete supporting structure until concrete has cured properly and is dry.
   2. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
   3. Do not use deck units for storage or working platforms until permanently secured.

C. Fastening Deck Units:
   1. Steel deck units shall be fastened to steel framework by the arc welding process. Welds shall be free of sharp points or edges. All welds shall be cleaned immediately, by chipping or wire brushing, and shall be coated with a zinc dust type primer paint.
   2. Welding shall conform to the applicable requirements of the AISC “Light Gauge Steel Design” and all welding shall be done by qualified welders. Welder qualifications shall be in accordance with AWS Specifications B3.0, "Standard Qualification Procedures."
   3. Decking sheets shall be fastened to the steel framework at all intermediate supports perpendicular to the deck ribs by 1/2-inch diameter fusion area puddle welds at each deck rib, unless otherwise shown on the Drawings.
   4. Weld deck units to parallel framing supports with 1/2-inch diameter fusion area puddle welds at 12-inches on center, unless otherwise shown on the Drawings.
   5. Welding at diaphragm boundaries shall be 1/2-inch diameter fusion area puddle welds at 12-inches on center, unless otherwise shown on the Drawings.
   6. Weld all connection angles and plates to supporting members and decking with 1/2-inch diameter fusion welds at 12-inches on center, unless otherwise shown on the Drawings.
   7. Any weld found to be defective shall be replaced before concrete is placed. Decking shall be erected and properly aligned prior to welding.

D. Cutting and Fitting:
   1. Cut and fit roof deck units and accessories around other work projecting through or adjacent to the roof decking, as shown on the Drawings. Provide neat, square and trim cuts.

E. Reinforcement at Openings:
   1. Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking and support other work, unless otherwise shown on the Drawings.
   2. Reinforce roof decking around openings less than 15-inches in any dimension by means of a flat steel sheet placed over the opening and fusion welded to the top surface of the deck. Provide steel sheet of the same quality as the deck units, not less than 20 gage, and at least 12-inches wider and longer than the opening. Provide welds at each corner and spaced not more than 12-inches on center along each side.

F. Cant Strips:
   1. Weld cant strips to the top surface of the roof decking, and secure to wood nailers with galvanized screws, and to steel framing with welds or galvanized self-tapping screws. Space fasteners or welds at 12-inches on center lap end joints not less than 3-inches, and secure with galvanized sheet metal screws.

G. Closure Strips:
   1. Provide metal closure strips at all open uncovered ends and edges of roof decking, and in the voids between decking and other construction. Weld into position to provide a complete decking installation.
      a. Provide flexible closure strips, instead of metal closures, at CONTRACTOR'S option, wherever their use will ensure complete closure. Install with adhesive in accordance with manufacturer's instructions.

H. Roof Insulation Support:
   1. Provide metal closure strips for the support of roof insulation where the rib openings in the top surface of roof decking occur adjacent to edges and openings. Weld closure strips into position.

I. Touch-Up Painting:
   1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 09 90 00, Painting and Coating.
   2. After roof decking installation has been completed, wire brush, clean and paint scarred and damaged areas, welds and rust spots on the supporting steel members in accordance with Section 09 90 00, Painting and Coating.
   3. Touch-up galvanized top and bottom surfaces of decking units with manufacturer’s recommended galvanizing repair paint applied in accordance with the manufacturer's instructions and recommendations.

+ + END OF SECTION + +

SECTION 05 50 00

MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish miscellaneous metal fabrications, including surface preparation and shop priming.

B. The extent of miscellaneous metal fabrications Work is shown on the Drawings and includes items fabricated from iron, steel and aluminum shapes, plates, bars, castings, and extrusions, which are not a part of the structural steel or other metal systems covered by other Sections of these Specifications.

C. The types of miscellaneous metal items include, but are not limited to the following:
   1. Aluminum ladders.
   2. Aluminum ladder safety cages.
   3. Shelf angles.
   4. Fall prevention system.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified:
   1. ASTM A 36, Specification for Carbon Structural Steel.
   2. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   4. ASTM A 320, Specification for Alloy Steel Bolting Material for Low Temperature Service.
   5. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   6. ASTM B 211, Specification for Aluminum and Aluminum-Alloy Bars, Rods and Wire.
   7. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   8. ANSI A14.3, Safety Requirements for Fixed Ladders.
   9. AWS D1.1, Structural Welding Code.
   10. NAAMM, Metal Finishes Manual.
   11. OSHA.
   12. Phoenix Building Code.

B. Field Measurements:
   1. Take field measurements where required prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

C. Shop Assembly:
   1. Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Samples:
   1. Sets of representative samples of materials including nosings, rungs and other finished products as may be requested by ENGINEER. ENGINEER'S review will be for color, texture, style, and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.
   2. Refer to and comply with the requirements of Section 01 33 23.15, Samples.

B. Shop Drawings:
   1. Fabrication and erection details of all assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for location and installation of miscellaneous metal items and anchorage devices.
   2. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
   3. Refer to and comply with the requirements of Section 01 33 00, Submittal Procedures and Section 26 05 01 General Provisions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A 36.

B. Aluminum:
   1. Alloy and Temper: Provide alloy and temper as shown on the Drawings or specified, or as otherwise recommended by the aluminum producer or finisher.
   2. Extruded Shapes and Tubes: ASTM B 221.
   3. Plate and Sheet: ASTM B 209.
   4. Bars, Rods and Wire: ASTM B 211.

C. Stainless Steel Plates and Sheets: ASTM A 240, Type 304L or Type 316 stainless steel.
   1. Submerged or intermittently submerged: Type 316 stainless steel.
   2. Non-submerged: Type 304L stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320.

E. Zinc Coated Hardware: ASTM A 153.

F. Surface Preparation and Shop Priming: Refer to Section 09 90 00, Painting and Coating. All steel shall be primed in the shop. Surface preparation and shop priming

requirements are included herein, but are specified in Section 09 90 00, Painting and Coating.

2.2 MISCELLANEOUS METAL ITEMS

A. Aluminum Ladders:
   1. Fabricate ladders for the locations shown on the Drawings, with dimensions, spacings, details and anchorages as shown on the Drawings, and specified. Comply with the requirements of ANSI A14.3, except as otherwise shown on the Drawings or specified.
      a. Unless otherwise shown on the Drawings, provide 1/2-inch by 2-1/2-inch continuous extruded flat bar side rails, spaced 18-inches apart, minimum.
      b. Provide extruded square rungs, spaced 12-inches on centers, maximum, with non-slip surface on the top of each rung. Adhesive strips for non-slip surfaces will not be allowed.
   2. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
   3. Support each ladder at top and bottom and at intermediate points spaced not more than five feet on centers. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold the ladder clear of the wall surface with a minimum of 7-inches clearance from wall to centerline of rungs. Unless otherwise shown on the Drawings or approved by the Engineer, extend rails 42-inches above top rung, and return rails to wall or structure, unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.
   4. Use extruded aluminum conforming to alloy and temper 6061-T6.

B. Aluminum Ladder Safety Cages:
   1. Fabricate ladder safety cages from extruded flat bars, assembled by welding or riveting. Unless otherwise shown on the Drawings, provide 1/2-inch by 3-inch top, bottom and intermediate hoops spaced not more than five feet on centers; and 3/8-inch by 2-inch vertical bars, secured to each hoop. Space vertical bars approximately 9- inches on centers. Fasten assembled safety cage to ladder rails and adjacent construction as shown on the Drawings. Grind all welds, sharp edges and projections smooth.
   2. Comply with the requirements of ANSI A14.3.
   3. Use extruded aluminum conforming to alloy and temper 6061-T6.

C. Shelf Angles:
   1. Provide structural steel shelf angles of sizes shown on the Drawings for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than 6-inches from ends and not more than 24-inches on centers, unless otherwise shown on the Drawings.
      a. Galvanize shelf angles shall be installed on exterior construction.

D. Fall Prevention System: All ladders shall be provided with a fall prevention system. The system shall meet OSHA standards.
   1. The system shall consist of a rail permanently attached to the ladder to which a harness belt is attached. The rail shall be notched and constructed of aluminum. Ladder attachments shall be provided as required by the

manufacturer. A removable extension section shall be provided at the top of the ladder.

2. Product and Manufacturer: Provide one of the following:
   a. Saf-T-Climb by Norton Company.
   b. Or equal.

E. Bollards: Provide 6-inch diameter, Schedule 80 black steel pipe, 4-feet-0-inches above grade, 2-feet-6-inches below grade. Fill with concrete with a 1-inch domed top. Bollards shall be primed in the shop. Surface preparation and painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

F. Miscellaneous Framing and Supports:
   1. Provide miscellaneous metal framing and supports, which are not a part of the structural steel framework and are required to complete the Work.
   2. Fabricate miscellaneous units to the sizes, shapes and profiles shown on the Drawings or, if not shown on the Drawings, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown on the Drawings, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill and tap units to receive hardware and similar items to be anchored to the Work.
   3. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
      a. Except as otherwise shown on the Drawings, space anchors, 24-inches on centers, and provide units the equivalent of 1-1/4 by 1/4 by 8-inch strips.
      b. Galvanize exterior miscellaneous frames and supports.
      c. Galvanize miscellaneous frames and supports where indicated.

G. Fasteners and Fittings: Provide Type 316 stainless steel, for all aluminum fabrications, and zinc coated hardware for all galvanized fabrications, unless otherwise shown on the Drawings or specified.

H. Surface Preparation and Shop Priming: All miscellaneous metal fabrications shall be primed in the shop. Surface preparation and shop priming requirements are included herein, but are specified in Section 09 90 00, Painting and Coating.

I. Aluminum Finish: Provide an Architectural Class 1 anodized finish, AA-M32C22-A41, as specified in NAAMM Manual.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set miscellaneous metal fabrications accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry or similar construction.

B. Anchor securely as shown on the Drawings or as required for the intended use, using concealed anchors wherever possible.

C. Fit exposed connections accurately together to form tight hairline joints. Weld steel connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind steel joints smooth and touch up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Protection of Aluminum from Dissimilar Materials:
   1. Coat all surfaces of aluminum in contact with dissimilar materials, such as concrete, masonry and steel conforming to the requirements of Section 09 90 00, Painting and Coating.

+ + END OF SECTION + +

SECTION 05 52 00.15

METAL RAILINGS ALUMINUM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install aluminum handrail and railing systems. The Work also includes:
      a. Providing openings in, and attachments to, aluminum handrail and railing systems to accommodate the Work under this and other Sections and providing for the aluminum handrail and railing systems all items such as anchor bolts, fasteners, studs, and all items required for which provision is not specifically included under other Sections.
   2. Extent of aluminum handrail and railing systems is shown on the Drawings and specified.
   3. Types of products required include the following:
      a. Custom fabricated top and intermediate horizontal railing system.
      b. Custom fabricated handrail system.
      c. Custom fabricated toe boards.
      d. Anchors and fasteners.
      e. Sleeves, castings, reinforcing inserts, wall brackets, gates, gate latches, stops and hinges, chains, and other miscellaneous accessories.
      f. Custom finished architectural Class I anodized finish for all system components.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the handrail and railing.
   2. Coordinate all handrail and railing locations as required for Work meeting all governing authorities.

1.2 SYSTEM DESCRIPTION

A. Aluminum handrail and railing system shall consist of equally spaced horizontal rails with totally concealed mechanical fasteners, internally threaded tubular rivets and adhesively bonded components fastened to posts spaced not more than 4 feet on center and a system of handrails supported from adjacent construction by mounting brackets spaced at not more than 4 feet on center.

B. Aluminum handrail and railing system shall include all components and features shown on the Drawings and specified and all system components and features available from specified manufacturers necessary to provide a complete aluminum handrail and railing system complying with these Specifications.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications:
   1. Engage a single firm, with undivided responsibility for performance of handrail and railing systems Work.
   2. Engage a firm, which can show five years previous successful experience in the fabrication of handrail and railing systems of scope and type similar to the required Work.
   3. Provide fabricator capable of providing custom details shown on the Drawings.
   4. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests shall not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

B. Installer Qualifications:
   1. Engage a single installer skilled, trained and with a record of successful experience in the installation of aluminum handrail and railing systems and who has a successful record of performing Work in accordance with the approved recommendations and requirements of the fabricator or who can submit evidence in writing of being acceptable to the fabricator; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualification to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owner, architects or engineers responsible for projects.
      b. Approximate contract cost of the handrails and railings.
      c. Amount of area installed.

C. Codes:
   1. Comply with the applicable requirements of OSHA and Phoenix Building Code.
   2. If there is a conflict between the OSHA requirements and the Phoenix Building Code comply with whichever requirement is more stringent.

D. Allowable Tolerances:
   1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
      a. Spacing: ±3/8-inch.
      b. Alignment: ±1/4-inch.
      c. Plumbness: ±1/8-inch.
   2. Minimum Handrails and Railings Systems Plumb Criteria:
      a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12 feet - 0 inches with posts set plumb to within 1/16-inch in 3 foot - 0 inches.
      b. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12 feet - 0 inches.
   3. Provide “pencil-line” thin butt joints.

E. Source Quality Control:
   1. Obtain all handrails and railings systems components and accessories from the same manufacturer.

F. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM B 26, Specification for Aluminum and Aluminum-Alloy Sand Castings.
   2. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
   3. ASTM B 136, Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum.
   4. ASTM B 137, Test Method for Measurement of Coating Mass Per Unit Area of Anodically Coated Aluminum.
   5. ASTM B 210, Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
   6. ASTN B 221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
   7. ASTM B 241, Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
   8. ASTM B 244, Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments.
   9. ASTM B 247, Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
   10. ASTM B 429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   11. ANSI A1264.1, Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems.
   12. The Aluminum Association, AA ASD-1, Aluminum Standards and Data.
   13. The Aluminum Association, AA SAA-46, Standards for Anodized Architectural Aluminum.
   14. The Aluminum Association, AA DSA-45, Designation System for Aluminum Finishes.
   15. Architectural Metal Products Division of The National Association of Architectural Metal Manufacturers, AMP/NAAMM, Pipe Railing Manual.
   16. Architectural Metal Products Division of The National Association of Architectural Metal Manufacturers, AMP 501, Finishes for Aluminum.
   17. OSHA, Title 29 Code of Federal Regulations Part 1910.23 - Guarding Floor and Wall Openings and Holes.
   18. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG.
   19. American National Standard Institute, A117.1, Accessible and Usable Buildings and Facilities.
   20. Phoenix Building Code.

G. Field Measurements: Take field measurements, where required, prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

H. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Drawings for the fabrication and erection of handrail and railing systems with sizes of members, components, and anchorage devices, all based on specified requirements. Include copies of manufacturer's specifications, standard and custom detail drawings and installation instructions for handrail and railing systems. Include all plans and elevations identifying the location of all handrail and railing systems, and details of sections and connections. Show all anchorage items.
   2. Profiles of handrail and railing systems components, and the details of forming, jointing, sections, connection, internal supports, trim, and accessories. Provide details drawn at 1-1/2-inch scale.
   3. All calculations for complete structural analysis of the handrail and railing systems including calculations showing compliance with system performance criteria specified. The calculations shall be prepared, signed and sealed by a Registered Professional Engineer licensed in the State of Arizona.
   4. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by ENGINEER.
   5. Maintenance Manuals: Upon completion of the Work, furnish copies of detailed maintenance manual including the following information:
      a. Product name and number.
      b. Name, address and telephone number of fabricator and manufacturer’s local distributor.
      c. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods and precautions as to use of materials that may be detrimental to finish when improperly applied.

B. Certification:
   1. Copies of material purchase receipts indicating actual materials purchased for this job, signed by a certified and licensed Notary Public, verifying that material purchased for the Work complies with material designations specified as confirmed by approved Shop Drawings.
   2. Manufacturer’s certificate on results of load testing the completed handrail and railing systems, demonstrating compliance with all applicable OSHA, ANSI and Phoenix Building Code requirements and the system performance criteria specified for superimposed loadings and deflection limitations.
   3. Finish: Furnish a written certificate confirming specified anodized coating film thickness, coating weight, sealing treatment and stain test performance.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver handrails and railings and all accessories dry and undamaged, with manufacturer's protective coating intact, bearing original intact factory labels identifying component’s location and use within the completed systems.
   2. Handrail and railing systems components, which are damaged during delivery or while being unloaded, shall not be stored on site. Remove such units from site and replace with new, undamaged material.

B. Storage of Materials:

1. Store handrail and railing systems components and accessory materials in a dry location and in a manner that will protect strippable coating from exposure to sun and condensation; with good air circulation around each piece and with protection from wind-blown rain.
2. Store handrail and railing systems components and accessory materials under tarpaulin covers and in an area protected from dirt, damage, weather and from the construction activities of all contractors. Do not store outside or allow items to become wet or soiled in any way while on site.
3. Do not store in contact with concrete, earth or other materials that might cause corrosion, staining, scratching or damage to finish. Do not install system components, which become dented, scratched or damaged in any way. Remove such components from site and replace with new, undamaged material.

C. Handling of Materials:
1. Do not subject handrail and railing systems components and accessory materials to bending or stress.
2. Do not damage edges or handle material in a manner that will cause scratches, warps or dents.
3. Keep on-site handling to a minimum.
4. Maintain protective covering on railings and handrails. All surface protective coverings such as nonadhesive papers, adhesive papers and strippable plastic films shall be removed after receipt at the site as soon as there is no longer a need for the protection.

1.6 JOB CONDITIONS

A. Protection: Protect cast-in-place sleeves from debris and water intrusion by use of temporary covers or removable foam inserts.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
1. Maintain the visual design concept shown on the Drawings, and the technical requirements specified, including modules, profiles, alignment of components and requirements for finish.
2. Provide handrail and railing systems that conform to the Phoenix Building Code and OSHA, Part 1910.23, including the 200 pound loading requirement. In addition, the system shall conform to the following requirements:
a. Completed railing and handrail systems shall withstand a uniform lateral force of 40 pounds per linear foot and a vertical uniform force of 50 pounds per linear foot, both applied simultaneously at the top of the handrail and railing.
b. Intermediate and bottom rails shall withstand simultaneously applied lateral uniform forces of 40 pounds per linear foot and a vertical load of 50 pounds per linear foot, however, lateral and vertical loads on intermediate and bottom railings need not be considered in the detailing and fabrication of posts and anchorages.

c. For railings having panels, the panels shall be detailed and fabricated to withstand a uniform lateral load of twenty pounds per square foot.
d. Concentrated 200 pound load and uniform force conditions shall not be applied simultaneously.
e. Other pertinent requirements ceded to ICC/ANSI 117.1, Accessible Building and Facilities, by the City of Phoenix Building Code.
f. Bending stresses shall not exceed 60 percent of the yield stress of the material. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.
g. Select schedule of pipe using alloys, minimum diameter, loadings, and maximum post spacing specified in order to limit deflection in each single-span of railing and handrail to 1.5-inches maximum and on railing posts to 1.4-inches maximum and with a safety factor of 1.65:1 for all Work.
h. Load test completed handrail and railing systems and submit results to ENGINEER. Provide written report identifying and documenting the testing methods used, the loads superimposed and how and where they were applied, and the results of such tests on actual complete handrail and railing systems including all anchors and fasteners to be used in the Work. The written report shall be signed and sealed by a Registered Professional Engineer licensed in the State of Arizona. Testing setup shall simulate actual conditions of installation to be used in the Work.

3. Thermal Control: Provide adequate expansion within fabricated systems that allows for a thermal expansion and contraction caused by a material temperature change of 140°F to -20°F without warp or bow of system components. Distance between expansion joints shall be based on providing a 1/4-inch wide joint at 70°F, which accommodates a movement of 150 percent of the calculated amount of movement for the specified temperature range.
4. Provide expansion joints in handrail and railing systems where systems cross expansion joints in structure.
5. Provide handrail and railing systems as shown on the Drawings. Where handrail or railing systems are required by either the governing authority or the Occupational Safety and Health Act of 1970, or the Americans with Disabilities Act of 1990, aluminum handrail and railing systems of the type specified herein shall be provided.
6. Configuration of all handrail and railing systems components shall be as shown on the Drawings. Verify dimensions at the site without causing delay in the Work.
7. Except where detailed dimensions are shown on the Drawings, indicate required locations for posts, space posts maximum 4 feet on centers.
8. Where details show post location requirements at or near end of runs, uniformly space intermediate posts as required to meet loading and deflection criteria specified, but not greater than maximum spacing specified. Where posts are shown at straight walkways and other locations where railing is provided on each side, locate railing system posts opposite each other; do not stagger.
9. Comply with custom fabricated handrail and railing systems details shown on the Drawings. Provide fabricator's standard details for conditions not shown on the Drawings and for general system assembly, unless otherwise specified. All details shown are typical; similar details apply to similar conditions, unless specifically otherwise shown on the Drawings.

10. Fabricator is responsible for structural analysis and detailing of handrails and railings systems. Provide complete structural calculations and verification of other system performance criteria and Shop Drawings for all handrail and railing members, anchors and all other support system components prepared, signed and stamped with the seal of a Licensed Professional Engineer licensed to practice in the State of Arizona and recognized as an expert in the specialty involved.

B. Fasteners and Supports:
   1. Provide the size, length and load carrying capacity required to carry the specified loadings required by performance criteria times a minimum safety factor of four.
   2. Where sizes are shown on the Drawings, the sizes shown shall be considered minimum. Increase size to comply with required system performance criteria loadings and minimum safety factor specified.
   3. All railing system posts shall be provided with a circular profile solid reinforcing bar with outside diameter equal to inside diameter of post. Each post shall receive one reinforcing bar.

2.2 MATERIALS

A. Extruded Aluminum Architectural and Ornamental Shapes: ASTM B 221, Alloy 6063-T52.

B. Aluminum Forgings: ASTM B 247.

C. Extruded or Drawn Aluminum Pipe and Tube:
   1. ASTM B 429 or ASTM B 241, Alloy 6063-T5, 6063-T52 or 6063-T832 as required by loadings, deflections and post spacings specified.
   2. Provide Schedule 40 pipe minimum, unless conditions of detail and fabrication require extra heavy pipe to comply with performance criteria specified.
   3. Provide all rails and posts with minimum outside diameter of 1.900-inches.

D. Reinforcing Bars: Solid, circular profile, 24-inch long, 6061-T6 aluminum reinforcing bars with same outside diameter as inside diameter of post.

E. Toe boards:
   1. Provide extruded ASTM 6063-T5 or T52 alloy aluminum toe boards, unless railing is mounted on curbs or other construction of sufficient height and type to meet the requirements of OSHA 1910.23. Bars or plates are not acceptable.
   2. Unless otherwise specified, toe boards shall meet requirements of OSHA Part 1910.23, Section (e).

F. Anchors and Fastenings:
   1. Type 316 stainless steel; minimum 1/2-inch diameter.
   2. Provide minimum of four bolt fasteners for each post where surface mounted posts are shown on the Drawings. Components shall be in accordance with manufacturer's recommendations and as acceptable to ENGINEER as shown on approved Shop Drawings.
   3. Concrete and Masonry Anchors: As specified in Section 03 15 19, Anchorage in Concrete.

4. Bolting Materials: As specified in Section 03 01 19, Anchorage in Concrete.

G. Castings:
   1. Provide high strength aluminum alloy brackets, flanges and fittings suitable for anodizing as specified.
   2. Aluminum-Alloy Sand Castings: ASTM B 26.

H. Connector Sleeves: Schedule 40, 5-inches long by 1.610-inches diameter.

I. Brackets and Flanges: Provide manufacturer's complete selection of standard and custom brackets and flanges for railing system posts and for handrail supports.

J. Sockets: Provide 6-inch deep by 2-1/2-inch outside diameter aluminum sockets with 3-1/2-inch wide socket cover on bottom of all sockets and on top and bottom of removable post sockets.

K. Hinges: Provide two self-closing aluminum hinges for each railing system gate shown on the Drawings.

L. Latches and Stops: Provide one latch and stop with rubber bumper and 1-inch diameter plastic knob for each railing system gate shown on the Drawings.

M. Chain, Snaps and Eye Bolts: Provide oblong 0.250-inch welded link, Type 316 stainless steel chain weighing 57 pounds per cubic foot, each link 1-1/8-inch by 7/16-inch. Provide stainless steel eyebolts, 1/4-inch stainless steel threaded quick links and heavy-duty swivel snaps with spring-loaded latch.

N. Custom Cover Flanges: 1/4-inch high by 4-inch diameter; aluminum.

O. System Components and Miscellaneous Accessories: Provide a complete selection of manufacturer's standard and custom aluminum handrail and railing systems components and miscellaneous accessories as may be required based on conditions and requirements shown on the Drawings, including, but not limited to, fascia flanges, post brackets, complete selection of one and two-piece handrail brackets for selection by ENGINEER including glass panel handrail mounting brackets, protective inserts, threaded bushing brackets, interlocking panel clips, clamps, channel adapters, end caps, post caps, adapters, glass panel framing sections and accessories, ADA-compliant accessories and similar items. Show the type and location of all such items on Shop Drawings.

P. Adhesive: Two-part waterproof epoxy-type as recommended by handrail and railing systems manufacturer.

Q. Non-Shrink, Non-Metallic Grout:
   1. Pre-mixed non-staining cementitious grout requiring only the addition of water.
   2. Product and Manufacturer:
      a. Euco N-S by The Euclid Chemical Company.
      b. Masterflow 713 by Master Builders Company.
      c. Or equal.

2.3 FABRICATION

A. General: Unless otherwise shown on the Drawings or specified in the Contract Documents provide typical non-welded construction details and fabrication techniques as recommended by AMP/NAAMM publications specified.

B. Form exposed Work true to line and level with accurate angles, surfaces and straight edges. Fabricate all corners without the use of fittings.

C. Form bent-metal corners to the radius shown on the Drawings without causing grain separation or otherwise impairing the Work. Use radius bends to form all changes in direction of handrail and railing systems. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces, or use prefabricated bends. Provide not less than 4-inch outside radius.

D. Provide chains across openings in railings where shown on the Drawings. Attach one end of each chain to a 1/4-inch eye bolt in the post and the other end attached by means of an approved heavy stainless steel swivel eye snap hook to a similar eye bolt in the opposite post.

E. Remove burrs from all exposed edges.

F. Locate intermediate rails equally spaced between top rail and finished floor.

G. Close aluminum pipe ends by using prefabricated fittings.

H. Weep Holes:
   1. Fabricate joints, which will be exposed to the weather so as to exclude water.
   2. Provide 15/64-inch diameter weep holes at the lowest possible point on all handrail and railing systems posts.
   3. Provide pressure relief holes at closed ends of handrail and railing systems.

I. Toe boards:
   1. Provide manufacturer's toe board detail, which accommodates movement, caused by thermal change specified without warping or bowing toe boards.
   2. Provide manufacturer’s toe board detail, which accommodates storage for removable socket covers.
   3. Coordinate and cope toe board as required to accommodate cover flanges at posts.
   4. Toe boards shall follow curvature of railing. Where railing is shown on the Drawings to have curved contours at corners, or other locations, the toe board shall likewise be curved to follow line of railing system.

J. Reinforcing Bars: Provide reinforcing bar friction-fitted at all railing system posts. Extend reinforcing bars or tubes 6-inches into cast-in-place sleeves or other types of supporting brackets.

K. Mechanically Fitted Component Pipe Handrail and Railing:
   1. Use a nonwelded pipe handrail and railing system with posts, top and intermediate rail(s) and flush joints.
   2. Provide a top and intermediate horizontal rail(s), equally spaced.

3. Blind rivets, pop rivets or other exposed fastening devices shall not be used in the Work. Fasteners used for side mounting fascia flanges where shown on the Drawings or specified may be exposed in the Work. Provide internal threaded tubular aluminum rivets, stainless steel through bolts with lock nuts, stainless steel sheet metal screws with lockwashers and epoxy adhesive for fastening all components of the Work.
4. Product and Manufacturer:
   a. Custom Fabricated Connectorail System by Julius Blum & Company, Incorporated.
   b. Custom Fabricated Series 500 Non-Welded Aluminum Pipe Aluminum handrails and railings system by Superior Aluminum Products, Incorporated.
   c. Or equal.

L. Mechanically Fitted Component Pipe Handrail and Railing:
1. Use a non-welded pipe handrail and railing system with posts, top and intermediate rail(s), and flush joints.
2. Provide a top and 2 intermediate horizontal rails, equally spaced.
3. Stainless steel Type 304/305 blind rivets and stainless steel Type 304/305 self-tapping screws shall be used to assemble all components of the Work.
4. Product and Manufacturer:
   a. Wesrail by Moultrie Manufacturing Company.
   b. Alumaguard by Alumaguard A Division of Bettinger West Incorporated.
   c. Or equal.

2.4 ALUMINUM COATINGS

A. General:
1. Prepare surfaces for finishing in accordance with recommendations of the aluminum producer and the finisher or processor.
2. Adjust and control the direction of mechanical finishes specified to achieve the best overall visual effect in the Work.
3. Color and Texture Tolerance: Provide uniform color and continuous mechanical texture for all aluminum components. ENGINEER reserves the right to reject aluminum materials because of color or texture variations, which are visually objectionable, but only where the variation exceeds the range of variations established by the manufacturer prior to fabrication, by means of range samples which have been accepted by ENGINEER.
4. Anodize all aluminum components of the Work.

B. Mechanically finish aluminum by wheel or belt polishing with aluminum oxide grit of 180 to 220 size, using peripheral wheel speed of 6,000 feet per minute; Aluminum Association Designation - M32 Medium Satin Directional Texture.
1. Hand Rubbed Finish: Where required to complete the Work and provide uniform, continuous texture, provide hand rubbed finish to match medium satin directional texture specified in order to even out and blend in satin finishes produced by other means.

C. Provide non-etching chemical cleaning by immersing the aluminum in an inhibited chemical solution, as recommended by the coating applicator, to remove all lard oil,

fats, mineral grease and other contamination detrimental to providing specified finishes.

1. Clean and rinse with water between steps as recommended by the aluminum manufacturer.

D. Exposed Aluminum Anodic Coating: Provide anodic coatings as specified, which do not depend on dyes, organic or inorganic pigments, or impregnation processes to obtain color. Apply coatings using only the alloy, temperature, current density and acid electrolytes to obtain specified colors in compliance with the designation system and requirements of the Aluminum Association and AMP 501 of AMP/NAAMM. Comply with the following:
   1. Provide Architectural Class I high density anodic treatment by immersing the components in a tank containing a solution of 15 percent sulfuric acid at 70°F with 12 amperes per square foot of direct current for minimum of sixty minutes; Aluminum Association Designation.
   2. Physical Properties:
      a. Anodic Coating Thickness, ASTM B 244: Minimum of 0.7 mils thick.
      b. Anodic Coating Weight, ASTM B 137: Minimum of 32 mg/sq. in.
      c. Resistance to Staining, ASTM B 136: No stain after five minutes dye solution exposure.
      d. Salt Spray, ASTM B 117: 30,000 hours exposure with no corrosion or shade change.
   3. Seal finished anodized coatings using deionized boiling water to seal the pores and prevent further absorption.
   4. Product and Manufacturer:a. Custom Fabricated Connectorail System by Julius Blum & Company, Incorporated.
      b. Custom Fabricated Series 500 Non-Welded Aluminum Pipe Aluminum handrails and railings system by Superior Aluminum Products, Incorporated.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the aluminum handrails and railings systems Work is to be performed and notify ENGINEER, in writing, of unsatisfactory tolerances which exceed specified limits and other conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Verify to ENGINEER gage of aluminum pipe railing posts and rails brought to the site by actual measurement of on-site material in the presence of ENGINEER.

3.2 INSTALLATION

A. General:
   1. Do not erect components, which have become scarred, dented, chipped, discolored or otherwise damaged or defaced. Railing and handrail system components, which have holes, cuts, gouges, deep scratches or dents of any

kind, shall be removed from the site before installation. Repairs to correct such Work will not be approved by ENGINEER. Remove and replace with new material.

2. Comply with installation and anchorage recommendations of AMP/NAAMM publications specified in addition to the requirements specified and approved Shop Drawings.

B. Fastening to In-Place Construction:
   1. Remove protective plastic immediately before installation.
   2. Adjust handrails and railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
      a. Anchor posts in concrete by means of sockets set and anchored into the concrete floor slab. Provide closure secured to the bottom of sleeve. Before installing posts remove all debris and water from sleeves. Verify that reinforcing bars have been inserted into posts before installation. Do not install posts without reinforcing bar. For all non-removable handrail and railing systems sections, after the posts have been inserted into the sockets, fill the annular space between posts and sockets solid with grout as specified in Section 03 60 00, Grouting. Crown grout and slope it to drain away from posts.
      b. Anchor posts to stair stringers with stringer or support flanges, angle type or floor type as required by conditions, shop-connected to posts and bolted to the steel supporting members. Flanges shall be as recommended by manufacturer. Verify that reinforcing bars have been inserted into posts before installation. Do not install posts without reinforcing bar.
      c. Side mount posts by fastening them securely in brackets attached to steel or concrete fascia as shown on the Drawings and in accordance with approved Shop Drawings.
      d. Provide removable railing sections where shown on the Drawings. Removable railing system posts shall be provided with friction fitted reinforcing bar in each post. Provide sockets with socket covers stored in extruded toeboard. Provide aluminum pipe collars for all removable posts. Accurately locate sleeves to match post spacings.
      e. All posts set in concrete shall be provided with an aluminum floor cover flange.
   3. Use devices and fasteners recommended by the handrail and railing systems manufacturer and as shown on the approved Shop Drawings.

C. Cutting, Fitting and Placement:
   1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.
   2. Fit exposed connections accurately together to form tight hairline joints. Do not cut or abrade the surfaces of units, which have been finished after fabrication, and are intended for field connections.
   3. Permanent field splice connections shall be made using manufacturer's recommended epoxy adhesive and 5-inch minimum length connector sleeves. Tight press-fit all field splice connectors and install in accordance with

manufacturer's written instructions. Follow epoxy manufacturer's recommendations for requirements of installation and conditions of use.

4. Permanent field splice connections shall be made using stainless steel blind rivets and 5-inch minimum length connector sleeves. Tight press-fit all field splice connectors and install in accordance with manufacturer's written instructions. Install two blind rivets per joint on 180 degree centers.
5. Make all splices as near as possible to posts but not exceeding 12-inches from nearest post.
6. Field welding will not be permitted. Make all splices using a pipe splice lock employing a single allen screw to lock joint.
7. Provide hinged railings sections as shown on the Drawings. Provide hinges and latch for connection to adjacent railing.
8. Provide chain sections as shown on the Drawings. Provide one chain length with fastening accessories for top and each intermediate rail.
9. Secure handrails to walls with wall brackets and end fittings as shown on the Drawings. Locate brackets as shown on the Drawings or, if not shown on the Drawings, at not more than 4 feet on centers.
10. Provide flush-type wall return fittings with the same projection as that shown for wall brackets. Drill wall plate portion of the bracket to receive one bolt, unless otherwise shown on the Drawings.
11. Secure wall brackets to building construction as follows:
    a. For concrete and solid masonry anchorage, use anchor bolt expansion shields and lag bolts.
    b. For hollow masonry anchorage, use toggle bolts having square heads.
12. Securely fasten toeboards in place with not more than 1/4-inch clearance above floor level.
13. Drill one 15/64-inch diameter weep hole not more than 1/4-inch above the top of location of solid reinforcing bar in each post.

D. Fastening to Existing Construction:
1. Provide heavy duty floor flange and anchorage devices and fasteners where necessary for securing handrail and railing systems components to existing construction; including stainless steel threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as required.
2. Use devices and fasteners recommended by the handrail and railing systems manufacturer and as shown on approved Shop Drawings.

E. Expansion Joints:
1. Provide slip joint with internal sleeve extending 2-inches minimum beyond joint on each side.
2. Construct expansion joints as for field splices, except fasten internal sleeve securely to one side of rail only.
3. Locate joints within 6-inches of posts.
4. Submit locations and details of all expansion joints to ENGINEER.

F. Protection from Dissimilar Materials:
1. Coat all surfaces of aluminum in contact with dissimilar materials such as concrete, masonry and steel as specified in Section 09 90 00, Painting and Coating.

2. Do not extend coating beyond contact surfaces. Remove coating where exposed-to-view in the finished Work.

3.3 CLEANING AND REPAIRING

A. Cleaning: Installer shall clean exposed surfaces of handrail and railing systems of every substance after completion of installation. Comply with recommendations of both the handrail and railing, and finish manufacturer. Do not use abrasives or non-approved solvent cleaners. Test cleaning techniques on an un-used section of railing before employing cleaning technique.
   1. Remove all stains, dirt, grease or other substances by washing handrails and railings systems thoroughly using clean water and soap; rinse with clean water.
   2. Do not use acid solution, steel wool or other harsh abrasives.
   3. If stain remains after washing remove defective sections and replace with new material conforming to the requirements of the Specification.

B. Leave handrails and railings, free from dents, burrs, scratches, holes and other blemishes. Replace damaged or otherwise defective Work with new material that conforms to the Specification requirements at no additional cost to OWNER.

C. At the completion of Work, replace adjacent work, marred by the Work of this Section.

+ + END OF SECTION + +

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SECTION 06 10 00

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, material, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all rough carpentry Work. The Work also includes:
      a. Providing openings in rough carpentry to accommodate the Work under this and other Sections and building into the rough carpentry all items such as sleeves, anchor bolts, inserts and all other items to be embedded in rough carpentry for which placement is not specifically provided under other Sections.
   2. The extent of the rough carpentry is shown on the Drawings.
   3. The types of rough carpentry Work required includes, but is not necessarily limited to, the following:
      a. Wood framing, blocking, furring strips and other miscellaneous wood framing.
      b. Plywood.
      c. Pressure treatment.
      d. Miscellaneous accessories, fasteners and anchorages.

B. Coordination:
   1. Coordinate compatibility of pressure treatment with elastomeric membrane sheet roofing Work. Provide wood treatment acceptable to manufacturer of elastomeric membrane sheet roofing used in the Work.
   2. Comply with the requirements of Section 07 50 00, Single Ply Membrane Roofing.

1.2 QUALITY ASSURANCE

A. Design Criteria:
   1. Lumber Standard: Comply with PS-20, except as otherwise specified.
   2. Phoenix Building Code.

B. Codes: Comply with the applicable requirements of the Uniform Building Code as supplemented by the City of Phoenix, Building Construction Code for size, spacing and attachment of wood members.

C. Source Quality Control:
   1. Factory-mark each piece of lumber and type, grade, mill and grading agency.
   2. Shop-fabricate rough carpentry Work to the extent feasible and where shop fabrication will result in better workmanship than feasible for on-site fabrication.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:

1. American Lumber Standard Committee, National Grading Rule for Dimension Lumber, PS-20.
2. American Lumber Standard Committee, Plywood Standard, PS-1.
3. American Wood Preservers Association, Standard, C-2.
4. Occupational Safety and Health Act of 1972.
5. West Coast Lumber Inspection Bureau, Grading Rules.
6. American Wood Preserver's Association, M4.
7. Federal Specification, TT-W-550, Wood Preservative: Chromated Copper Arsenate Mixture.
8. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of chemical treatment manufacturer's instructions for proper use of each type of treated material.
   2. For water-borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to project site.

B. Certificates: Pressure Treatment: For each type specified, include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Storage of Materials:
   1. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.
   2. Keep materials dry during delivery and storage.
   3. Protect against exposure to weather and contact with damp or wet surfaces.
   4. Stack lumber, and provide air circulation within stacks.

B. Handling Materials: Handle all treated products as specified in American Wood Preservers' Association, M4.

1.5 JOB CONDITIONS

A. Coordination: Fit rough carpentry Work to other work and scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber, General:
   1. Nominal sizes are shown on the Drawings, except as shown by detail dimensions. Provide actual sizes as required by American Lumber Standard

Committee, National Grading Rule for Dimension Lumber PS-20, for the moisture content specified for each use.

a. Provide dressed lumber, S4S, unless otherwise shown on the Drawings or specified.
b. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing.

2. Provide the following grade and species:
   a. Construction Grade.
   b. Douglas Fir, WWPA, or Southern Pine, SPIB, or Redwood.

B. Plywood:
   1. Exterior Type: Grade CC/EXT-APA, 3/4-inch thick.
   2. American Lumber Standard Committee, Plywood Standard, PS-1.

C. Fasteners and Anchorages:
   1. Provide size and type as recommended by the Phoenix Building Code standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices.
   2. Provide Type 316 stainless steel fasteners and anchoring devices for all submerged and exterior Work. Provide zinc coated nails for all other uses.

D. Lumber for Protection and Temporary Support: Size and grades to meet applicable requirements of the Occupational Safety and Health Act and structural requirements.

2.2 WOOD TREATMENT

A. Preservative Treatment: Where lumber is specified herein to be treated, comply with the applicable requirements of the American Wood Preservers Association (AWPA). Mark each treated item to comply with the AWPA Quality Mark requirements for the specified requirements.
   1. Pressure-treat above ground items with water-borne preservatives complying with AWPA C-2. After treatment, kiln-dry to a maximum moisture content of 19 percent. Treat indicated items and the following:
      a. Wood cants, nailers, blocking, stripping, and similar members in connection with roofing, flashing and vapor barriers.
      b. Wood sills, plate, blocking, furring, stripping and similar concealed members and all wood in contact with masonry, plaster, concrete or steel.

B. Provide chromated copper arsenate Type II or B wood preservative complying with FS TT-W-550.

C. Complete fabrication of treated items prior to treatment, wherever possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of lumber after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and supporting structure and the conditions under which the rough carpentry Work is to be installed and notify ENGINEER, in writing, of the conditions detrimental to the Work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General:
   1. Discard units of material with defects which might impair the quality of the Work and units which are too small to fabricate the Work with minimum joints or the optimum joint arrangement.
   2. Set rough carpentry Work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
   3. Securely attach rough carpentry Work to substrates by anchoring and fastening as shown on the Drawings and as required by recognized standards. Countersink nail heads on exposed rough carpentry Work and fill holes. Use common wire nails, except as otherwise shown on the Drawings. Use finishing nails for finish Work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood and predrill as required.

B. Wood Grounds, Nailers, and Blocking
   1. Provide wherever shown on the Drawings and where required for attachment of other work. Form to shapes as shown on the Drawings and cut as required for true line and level of Work to be attached. Coordinate location with other work involved.
   2. Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown on the Drawings.
   3. Provide permanent grounds of dressed, preservative treated, key- beveled lumber not less than 1-1/2-inch wide and of the thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds, when no longer required.

C. Wood Framing: Install plumb and level in accordance with the requirements of the Phoenix Building Code. Provide wood framing for eaves, overhangs, roof penetrations and similar conditions.

D. Plywood: Install as shown on the Drawings and in accordance with the requirements of the Phoenix Building Code. Allow for installed clearances between individual plywood panels as specified by the plywood manufacturer.

+ + END OF SECTION + +

SECTION 06 74 13

FIBERGLASS REINFORCED PLASTIC GRATINGS, HANDRAILS, AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install fiberglass grating. The Work also includes:
      a. Providing grating to accommodate the Work under this and other Sections and attaching to the grating and all items such as fasteners and all items required including embedded angles for which provision is not specifically included under other Sections.
      b. Providing Fiberglass Reinforced Plastic (FRP) angles where shown on the Drawings or required for embedment in concrete or support of gratings.
   2. All equipment furnished under this Section shall be the product of a single manufacturer.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM D 635, Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   2. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   3. National Bureau of Standards, PS 15-69.
   4. OSHA.
   5. Standards of the Reinforced Plastic/Composites Institute.
   6. Phoenix Building Code.

B. Source Quality Control:
   1. Obtain all grating components and accessories from the same manufacturer.

C. Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication where required, to ensure proper fitting of the Work.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Shop Drawings for the fabrication and erection of all Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
   2. Setting drawings and templates for location and installation of anchorage devices.

3. Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.
4. The Work shall not be fabricated until CONTRACTOR submits field measurements of the openings and until the manufacturer's drawings based upon CONTRACTOR'S measurements have been approved by ENGINEER.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

A. The manufacturer shall furnish grating to conform to the following criteria:
   1. Rectangular mesh grating.
      a. Pattern 1-1/2-inch on center with 1/2-inch openings.
      b. Thickness: 2-inches.
      c. Bar width: 1-inch.
   2. Maximum Clear Span Deflection (under uniform load equal to 250 lbs./ft.2) 1/200 of span or 1/4-inch, at four feet, whichever is smaller.
   3. Fire Resistance: 25, ASTM E 84; self-extinguishing ASTM D 635.
   4. Sheet size: As shown on the Drawings, or as required to meet deflection requirements.
   5. Provide checker plate where shown on the Drawings.

2.2 MATERIALS

A. Fiberglass Reinforced Plastic: Premium grade, fire retardant vinylester resin with glass reinforcement. Provide a non-skid surface.

B. Attachment and Clips: Type 316 stainless steel clips, bolts, nuts and washers.

C. Color: Green.

D. Manufacturing Method: Grating shall be constructed by the pultrusion method.

E. Product and Manufacturer: Provide one of the following:
   1. Fibergrate Corporation.
   2. Duradek by Morrison Molded Fiberglass Co.
   3. IKG Borden, Inc.
   4. Or equal.

2.3 FABRICATION

A. Use materials of the minimum size and thickness as specified above, unless otherwise shown on the Drawings. Work to the dimensions shown on approved Shop Drawings.

B. Grating shall be as shown on the Drawings and shall comply with the standards of the Reinforced Plastic/Composites Institute, except as specified herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners to secure grating to supporting members or prepared openings, as shown on the Drawings and recommended by the manufacturer.

B. Cutting, Fitting and Placement:
   1. Perform all cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true and free of rack. Do not use wedges or shimming devices.
   2. Make cutouts or openings in the field as approved by ENGINEER.
   3. All grating which requires cutting during installation shall have the effected surfaces sealed with catalyzed resin sealant of equal or superior corrosion resistance to the grating as recommended by the manufacturer.
   4. Secure grating to fiberglass structural members, as specified by the manufacturer.
   5. Fit exposed connections accurately together to form tight joints.
   6. Secure edges of grating to each other with end panel clips.
   7. Secure clips to grating with bolts such that the grating shall act as a unit. Place bolts not more than 3-inches from each plate section end and not more than 24-inches on center.

+ + END OF SECTION + +

SECTION 07 21 00

BUILDING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all building insulation.
   2. Extent of each type of building insulation is shown on the Drawings.
   3. Types of products required include the following:
      a. Glass fiber batt insulation.
      b. Recycled glass fiber batt insulation.
      c. Extruded polystyrene plastic insulation.
      d. Preformed concrete masonry unit polystyrene plastic insulation.
      e. Foamed-in-place cementitious insulation.
      f. Mineral fiber insulation.
      g. Loose granular perlite insulation.
      h. Fire-stop sealants and other fire-stop system components.
      i. Miscellaneous materials and accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the building insulations.

1.2 QUALITY ASSURANCE

A. Manufacturer/Installer Qualifications:
   1. Obtain all foamed-in-place cementitious insulation from a manufacturer who is a licensed manufacturer of the product developer and who will also be responsible for the installation of foamed-in-place cementitious insulation.
   2. Engage single installers for each type of building insulation who are skilled, trained and have a record of successful experience in the application of each product and who have a successful record of performing the Work in accordance with the recommendations and requirements of the manufacturer or who can submit evidence, in writing, of being acceptable to the manufacturer and who agree to employ only tradesmen with specific skill and successful experience in each type of Work. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owners, architects or engineers responsible for projects.
      b. Approximate contract cost of the building insulation system installed.
      c. Amount of area installed.

B. Source Quality Control:
   1. Obtain building insulations, requiring a hydrochlorofluorocarbon blowing agent, from manufacturers who manufacture specified insulation using a blowing agent

acceptable for use until the year 2020 complying with the requirements of the Copenhagen Amendments to the Montreal Protocol in all ways.

2. Provide a manufacturer who will provide complete technical services including preparation and review of Shop Drawings, installation methods and proposed detailing for the Work.

C. Performance Criteria:
   1. Thermal Conductivity: The thicknesses shown on the Drawings are for the thermal conductivity, k-value at 75°F, specified for each material.
   2. Provide adjusted thicknesses, based on thicknesses shown on the Drawings or specified for building insulations, as required to comply with required thermal resistances for use of material having a different thermal conductivity.

D. Requirements of Regulatory Agencies: Comply with fire-resistance and flammability ratings as shown and specified; and comply with the Phoenix Building Code.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM C 165, Test Method for Measuring Compressive Properties of Thermal Insulations.
   2. ASTM C 177, Test Methods for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   3. ASTM C 203, Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
   4. ASTM C 236, Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
   5. ASTM C 272, Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
   6. ASTM C 303, Test Method for Dimensions and Density of Preformed Block-Type Thermal Insulation.
   7. ASTM C 518, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Heat Flow Meter Apparatus.
   8. ASTM C 520, Test Methods for Density of Granular Loose Fill Insulations.
   9. ASTM C 531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Monolithic Surfacings, and Polymer Concrete.
   10. ASTM C 549, Specification for Perlite Loose Fill Insulation.
   11. ASTM C 553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
   12. ASTM C 578, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   13. ASTM C 612, Specification for Mineral Fiber Block and Board Thermal Insulation.
   14. ASTM C 665, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   15. ASTM C 764, Specification for Mineral Fiber Loose-Fill Thermal Insulation.
   16. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C.
   17. ASTM D 1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
   18. ASTM D 1622, Test Method for Apparent Density of Rigid Cellular Plastics.

19. ASTM D 2126, Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
20. ASTM D 2842, Test Method for Water Absorption of Rigid Cellular Plastics.
21. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
22. ASTM E 96, Test Methods for Water Vapor Transmission of Materials in Sheet Form.
23. ASTM E 119, Standard Methods of Fire Tests of Building Construction and Materials.
24. Underwriters Laboratories, Incorporated, UL 1479, Fire Tests of Through-Penetration Firestops.
25. Phoenix Building Code.
26. Phoenix Energy Conservation Code.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. 12-inch by 12-inch samples of each required type of building insulation. Refer to and comply with Section 01 33 23.15, Samples.
   2. Samples will be reviewed by ENGINEER for color and texture only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of material specifications, installation instructions and general recommendations from the building insulation manufacturers, for each type of building insulation product. Include manufacturer’s data substantiating that the materials comply with specified requirements.
   2. Complete selection of fire stop manufacturer's recommended systems for each condition and kind of penetration encountered in the Work. Coordinate with equipment manufacturers for required number and kind of penetrations through fire-rated construction. Provide a schedule of penetrations and the fire stop system to be included for each condition and kind of penetration encountered.
   3. Drawings showing extent of the Work and all details required for the Work referencing system components provided as samples to ENGINEER.
   4. Indicate by copy of transmittal form that installer has received copy of manufacturer's installation instructions.

C. Test Reports: Submit for approval the following:
   1. Copies of test reports verifying compliance with physical properties and environmental features specified herein.
   2. Copies of testing agencies background and experience in performing similar tests to those specified.

D. Certificates: Submit for approval copies of certificates stating that the manufacturer of the foam-type rigid board insulation has used an environmentally safe blowing agent complying with specified requirements.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver building insulation products in manufacturer's original, unopened, factory-sealed containers, bearing manufacturer's name and labels, accurately representing container contents as shown on approved Shop Drawings.
2. Damaged materials shall be permanently removed from site by CONTRACTOR.
3. Do not deliver insulation materials to the site before the time of installation.
4. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
5. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage and Handling of Materials:
1. Store materials in original, undamaged containers with manufacturer's labels and seals intact.
2. Store all materials in a dry, enclosed area, off the ground and away from all possible contact with water.
3. Prevent damage to materials during storage, primarily by minimizing the amount of time they are stored on-site before being incorporated into construction systems. Store only sufficient quantity of building insulation materials on-site as necessary for the continuous advancement of the Work without causing delay.
4. Handle materials carefully in order to avoid damage and breakage or compressing of boards to less than their specified thickness, or other damage.
5. Do not open containers, or expose materials to detrimental conditions or physical damage. Materials which are so exposed shall be removed from the site and shall not be incorporated into the Work. If incorporated into the Work they shall be removed, at no additional expense to OWNER.
6. Handle materials in a manner which prevents inclusion of foreign materials.
7. Do not open packages or containers until all necessary preparatory Work is complete and installation will begin immediately.

1.5 JOB CONDITIONS

A. Protection:
1. Do not allow building insulation materials to become wet or soiled. Provide continuous protection of materials against damage, wetting and moisture absorption primarily by storing materials under cover and above ground and away from all other construction traffic.
2. Protect foam plastic building insulation from exposure to sunlight.
3. Do not allow building insulations to come into contact with welding operations or other fire or ignition sources.
4. Do not overload the building structure or damage in-place construction system with the weight of stored materials or use of equipment.
5. Protect materials against damage by construction activities.

B. Scheduling:
1. Proceed with building insulation Work only when preceding Work is ready to receive the Work of this Section.
2. Proceed with the building insulation and associated Work only after curbs, blocking, substrate board, nailer strips, vents, drains and other projections

through the substrates have been installed, and when the substrate construction and framing of openings is complete.

3. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the building insulation and backfilling operations are at the site and are ready to follow with the Work in a manner which will not leave the Work vulnerable to damage or deterioration.
4. Do not advance the installation of building insulation materials beyond that which is necessary for proper sequencing of the Work. Do not advance Work when there is no proper and secure protection from damaging weather and construction activities.

C. Environmental Conditions:
1. Complete the installation and concealment of building insulation materials as rapidly as possible in order to avoid damage from adjacent construction operations and adverse weather conditions.
2. Install building insulations only when weather and temperature conditions comply with building insulations manufacturers' written recommendations.
3. Install building insulations only when damaging environmental condition are not forecasted for the time when exposed systems materials components would be exposed to potential damage.
4. Install foamed-in-place cementitious insulation only when the combination of interior and exterior temperatures are such that the temperature at the point of application is 40°F and rising during the application process and 48 hour initial curing period.
5. If CONTRACTOR wishes to advance the foamed-in-place cementitious insulation Work when weather conditions are not within manufacturer's recommended temperature ranges, provide enclosures with heat to maintain manufacturer's recommended temperatures during the initial curing period. Erecting and maintaining all such enclosures and the provision of heat and heating equipment shall be at no additional cost to OWNER.
6. Protect Work from precipitation and direct sun.
7. Do not apply pressure sensitive tape when temperature is below 35°F or above 110°F.
8. Record decisions, conditions and agreements to proceed with the Work when weather conditions might be unfavorable. State the reasons for proceeding, along with the names of persons involved, and any changes or revisions, if required, to allow the Work to proceed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Glass Fiber Insulations: Provide the following types:
1. General: Provide insulations formed from glass fibers and resinous binders fabricated into flexible blankets, semi-rigid and rigid sheets complying with ASTM C 665, ASTM C 553 and ASTM C 612.
2. General: Provide unfaced, polyethylene encapsulated insulation formed from glass fibers certified by Scientific Certification Systems Incorporated as containing a minimum of 25 percent total recycle glass content with a minimum of 18 percent obtained from post-consumer recycled bottle glass and

thermosetting acrylic resin binders fabricated into flexible blankets, complying with ASTM C 665.

3. Unfaced Batt Insulation: Provide unfaced thermal batt insulation complying with ASTM C 665, Type I.
   a. Physical Properties.
      1) Thermal Conductivity (k), ASTM C 518: 0.33 Btu/in./hr./sf/°F maximum.
      2) Density, ASTM C 303: 1.5 pcf.
      3) Flame Spread, ASTM E 84: 25 maximum.
      4) Smoke Developed, ASTM E 84: 50 maximum.
   b. Thickness: 6 minimum.
   c. Width: 24 inches.
   d. Product and Manufacturer: Provide one of the following:
      1) Unfaced Thermal Batt Insulation by Owens-Corning Fiberglas Corporation.
      2) Unfaced Thermal Batt Insulation by Schuller International.
      3) Or equal.
4. Flame-Resistant Vapor Barrier Faced Batt Insulation: Provide thermal batt insulation, faced on one side with a foil-reinforced-kraft laminate vapor barrier complying with ASTM C 665, Type III, Class A.
   a. Physical Properties:
      1) Thermal Conductivity (k), ASTM C 518: 0.33 Btu/in./ hr./sf/°F maximum.
      2) Density, ASTM C 303: 1.5 pcf.
      3) Water Vapor Transmission, ASTM E 96: 0.10 perm/inch.
      4) Flame Spread, ASTM E 84: 25.
      5) Smoke Developed, ASTM E 84: 50.
      6) Fuel Contributed, ASTM E 84: 50.
   b. Thickness: 6 minimum.
   c. Width: 24 inches.
   d. Product and Manufacturer: Provide one of the following:
      1) FS-25 FRK Faced Thermal Batt Insulation by Owens-Corning Fiberglas Corporation.
      2) FSK-25 Thermal Batt Insulation by Schuller International.
      3) Or equal.
5. Non-Load-Bearing Semi-Rigid Board Insulation: Provide thermal semi-rigid board insulation complying with ASTM C 612, Classes 1A and 1B.
   a. Physical Properties:
      1) Thermal Conductivity (k), ASTM C 518: 0.23 Btu/in./ hr./sf/°F.
      2) Density, Manufacturer's Certified Test: 3 pcf.
      3) Compressive strength (psi at 10 percent deformation): 100 psi.
      4) Flame Spread, ASTM E 84: 15.
      5) Smoke Developed, ASTM E 84: 0.
   b. Thickness: 6 inches.
   c. Width: 24-inches.
   d. Length: 48-inches.
   e. Product and Manufacturer: Provide one of the following:
      1) Type 703, 700 Series Board Insulation by Owens-Corning Fiberglas Corporation.
      2) Insul-Shield Thermal Board Insulation by Schuller International.
      3) Or equal.

6. Rigid Board Insulation: Provide thermal rigid board insulation complying with ASTM C 612, Classes 1A and 1B.
   a. Physical Properties:
      1) Thermal Conductivity (k), ASTM C 518: 0.23 Btu/in./ hr./sf/°F.
      2) Density, Manufacturer's Certified Test: 6 pcf.
      3) Compressive Strength (psi at 10 percent deformation): 350 psi.
      4) Flame Spread, ASTM E 84: 15.
      5) Smoke Developed, ASTM E 84: 0.
   b. Thickness: 6-3/4-inches.
   c. Width: 24-inches by 48-inches
   d. Length: 48-inches.
   e. Product and Manufacturer: Provide one of the following:
      1) Type 705, 700 Series Board Insulation by Owens-Corning Fiberglas Corporation.
      2) Insul-Shield Thermal Board Insulation by Schuller International.
      3) Or equal.
7. Recycled Glass Fiber Insulation Batts: Provide encapsulated thermal insulation batts complying with ASTM C 665, Type I.
   a. Physical Properties: Provide the following:
      1) Thermal Conductivity (k), ASTM C 518: 0.32 Btu/in./hr./sf/□F.
      2) Density, ASTM C 303: 1.5 pcf.
      3) Water Vapor Transmission, ASTM E 96: 0.10 perm/inch.
      4) Flame Spread, ASTM E 84: 25.
      5) Smoke Developed, ASTM E 84: 50.
   b. Thickness: 6-3/4-inches.
   c. Nominal Width: 24-inches by 48-inches.
   d. Product and Manufacturer: Provide one of the following:
      1) Grid-SHIELD Thermal Batt Insulation by Schuller International, Incorporated.
      2) Or equal.

B. Foam Plastic Insulations: Provide the following types:
   1. General: Rigid, closed-cell, thermally stabilized, extruded, hydrochloro-flurocarbon blown, foam board insulation consisting of 100 percent virgin extruded polystyrene modified resin complying with ASTM C 578.
   2. Provide a blowing agent with lowest available ozone depletion potential, such as HCFC-142b, or better. HCFC-141b will not be approved by ENGINEER.
   3. Perimeter Foundation Insulations: Provide very high-load-resisting, rigid foam board insulation complying with ASTM C 578, Type V.
      a. Physical Properties: Provide the following:
         1) Thermal Conductivity (k), ASTM C 177 and ASTM C 518: 0.20 Btu/in./hr./sf/°F.
         2) Compressive Strength (psi at 5 percent deformation) ASTM D 1621: 100 psi minimum.
         3) Flexural Strength, ASTM C 203: 100 psi minimum.
         4) Coefficient of Thermal Expansion, ASTM D 696: 3.5 x 10-5 inches/in./°F.
         5) Water Vapor Absorption, ASTM C 272: Less than 0.1 percent by volume maximum.
         6) Water Vapor Permeance, ASTM E 96: 0.3 to 0.8 perms/inch maximum.

7) Flame Spread, ASTM E 84: 5.
8) Smoke Developed, ASTM E 84: 165 maximum.

b. Thickness: 3 layers each 2-inches.
c. Width: 24-inches.
d. Length: 96-inches.
e. Product and Manufacturer: Provide one of the following:
1) STYROFOAM 100 HIGH LOAD by The Dow Chemical Company.
2) Foamular 1000 by Owens-Corning Fiberglas Corporation.
3) Or equal.

4. Cavity Wall Rigid Insulation Board: Provide the following:
a. Rigid, rectangular boards of extruded polystyrene complying with ASTM C 578, Type X and IV.
b. Physical Properties: Provide the following:
1) Minimum Compressive Strength, (at ten percent deformation), ASTM D 1621: 25 psi.
2) Flame Spread, ASTM E 84: 10 maximum.
3) Smoke Development, ASTM E 84: 165 maximum.
4) Vapor Transmission, ASTM E 96: 1.1 perms/inch.
5) Thermal Resistance, ASTM C 177: 5.0/inch.
6) Maximum Water Absorption, ASTM C 272: 0.10 percent by volume.
c. Size: 1 layers of 16-inches by 96-inches by 6 inches thick.
d. Product and Manufacturer: Provide one of the following:
1) CAVITYMATE Plus by The Dow Chemical Company.
2) Foamular 250 Square Edge by Owens-Corning Fiberglas Corporation.
3) Or equal.

5. Preformed Concrete Masonry Unit Core Insulation: Provide individually molded expanded polystyrene core insulation complying with ASTM C 236, and ASTM C 578, Standard Type I.
a. Physical Properties:
1) Thermal Conductivity (k), ASTM C 177: 0.26 Btu/in./ hr./sf/°F.
2) Density, ASTM C 303: 0.90 to 1.14 pcf minimum.
3) Compressive Strength (psi at five percent deformation), ASTM D 1621: 10 to 13 pcf.
4) Water Vapor Transmission, ASTM E 96: 1.4 perm/inch.
5) Dimensional Stability: ASTM D 2126: 0.55 percent maximum.
6) Flame Spread, ASTM E 84: 5 maximum.
7) Smoke Development, ASTM E 84: 130 maximum.
b. Product and Manufacturer: Provide one of the following:
1) Korfil Standard U-Shaped Block Insulation by Concrete Block Insulating Systems Incorporated, a Division of W. R. Grace Construc-tion Products, Incorporated.
2) Blocfil by Blocfil Company, Division of Patek Investment Corpor-ation.
3) Or equal.

6. Extruded Compression-Resistant Rigid Foam Board Insulation: Provide 100 percent virgin extruded polystyrene modified resin foam board complying with ASTM C 578, Type VII.
a. Physical Properties:
1) Thermal Conductivity (k), ASTM C 177 and ASTM C 518: 0.20 Btu/in./hr./sf/°F.

2) Compressive Strength (psi at five percent deformation) ASTM D 1621: 60 psi.
3) Coefficient of Thermal Expansion, ASTM D 696: 2.7 x 10-5 inches/in./°F.
4) Water Vapor Absorption, ASTM C 272: Less than 0.1 percent by volume maximum.
5) Water Vapor Permeance, ASTM E 96: 1.1 perms/inch maximum.
6) Flame Spread, ASTM E 84: 5.
7) Smoke Developed, ASTM E 84: 165 maximum.

b. Thickness: 6 inches.
c. Width: 24-inches.
d. Length: 96-inches.
e. Product and Manufacturer: Provide one of the following:
1) PLAZAMATE by the Dow Chemical Company.
2) FOAMULAR 600 by Owens-Corning Fiberglas Corporation..
3) Or equal.

C. Foamed-In-Place Cementitious Insulation: Provide the following:
1. Provide an ultra lightweight, non-corrosive, insulating foam, which will not shrink or settle, is recommended by the manufacturer for high temperature installations, and consists of a combination of inorganic cementitious stabilizer, a microscopic cell generator, a catalyst and compressed air, foamed to a density of 2.07 pounds per cubic foot minimum.
2. Environmental Profile: Provide a foamed-in-place cementitious insulation free of hydrochlorofluorocarbon blowing agents, mineral fibers, asbestos, formaldehyde, and which is 98 percent inorganic, which contributes no harmful gases under flaming and smoldering conditions, and is non-hazardous as waste material.
3. Physical Properties: Provide the following:
a. Dimensional Stability, ASMT C 531: Shrinkage: 0.
b. Flame Spread, ASTM E 84: 0.
c. Smoke Developed, ASTM E 84: 0.
d. Fuel Contributed, ASTM E 84: 0.
e. Thermal Conductivity (k), ASTM C 518: 0.257.
4. Product and Manufacturer: Provide one of the following:
a. "Air Krete" cementitious foam insulation by Air Krete Incorporated.
b. Or equal.

D. Mineral Fiber Insulation: Provide the following types:
1. General: Provide insulations formed from inorganic mineral fiber extrusions spun at 2500°F complying with ASTM C 665 and ASTM C 764.
2. Loose Mineral Fiber Insulation: Provide non-asbestos rock, slag or glass processed into fiber and formed into loose resilient wool mass or granular nodules complying with ASTM C 764, Type 1 (for blowing) Type 2 (for pouring).
a. Physical Properties:
1) Thermal Conductivity (k), ASTM C 764: 0.46 Btu/in./ hr/sf/°F.
2) Ignition Loss: Less than 1 percent (99 percent pure mineral fiber).
3) Density, ASTM C 64: 1.5 pcf.
b. Product and Manufacturer: Provide one of the following:
1) Industrial Mineral Wool Fiber by Rock Wool Industries, Incorporated.
2) FBX Insulating Wool by Fibrex Incorporated.

3) Or equal.

3. Sound Attenuation Fire Blanket Insulation: Provide insulation containing non-asbestos, non-combustible compounds of spun mineral fiber felt formed into flexible, resilient blankets complying with ASTM C 665, Type I.
   a. Physical Properties:
      1) Thermal Conductivity (k), ASTM C 518: 0.27 Btu/in./ hr/sf/°F.
      2) Density, Manufacturer's Certified Test: 2.5 pcf.
   b. Thickness: 6 inches.
   c. Width: 24 inches.
   d. Product and Manufacturer: Provide one of the following:
      1) Thermafiber SAFB Batts by USG Interiors, Incorporated.
      2) Sound Control Fire Blankets by Fibrex Incorporated.
      3) Or equal.
4. Safing Insulation: Provide unfaced semi-rigid non-asbestos, non-combustible blankets composed of compounds of spun mineral fiber felt, complying with ASTM C 665, Type I.
   a. Physical Properties:
      1) Thermal Conductivity (k), ASTM C 518: 0.25 Btu/in./ hr/sf/□F.
      2) Density, Manufacturer's Certified Test: 4 pcf.
      3) Flame Spread, ASTM E 84: 15 maximum.
      4) Smoke Developed, ASTM E 84: 5 maximum.
      5) Fire Resistance Rating, ASTM E 119: 3 hours.
   b. Thickness: 4-inches.
   c. Width: 24-inches.
   d. Product and Manufacturer: Provide one of the following:
      1) Thermafiber Safing Insulation by USG Interiors, Incorporated.
      2) FBX Safing Insulation by Fibrex Incorporated.
      3) Or equal.

E. Loose Granular Perlite Insulations: Provide the following:
   1. Loose Fill Insulation: Provide inert asbestos-free volcanic glass-like perlite aggregates expanded by a special heat process and treated with non-flammable silicone complying with ASTM C 549.
      a. Physical Properties:
         1) Thermal Conductivity (k), ASTM C 549: 0.37 Btu/in./ hr/sf/°F.
         2) Density, ASTM C 520: 5 to 8 pounds per cubic foot.
         3) Flame Spread, ASTM E 84: 0.
         4) Fuel Contributed, ASTM E 84: 0.
         5) Smoke Development, ASTM E 84: 0.
      b. Product and Manufacturer: Provide one of the following:
         1) Permalite by Grefco Incorporated.
         2) Or equal.

F. Fire-Stop Sealants and Other Fire-Stop System Components: Provide the following:
   1. Complete selection of fire stop manufacturer's recommended silicone rubber fire stop systems. Provide complete systems complying with UL 1479 with a two or three hour fire rating. Provide equal fire protection as provided by fire-rating of construction penetrated.
   2. Provide multiple component systems coordinated to meet actual conditions encountered in the Work and as recommended by the fire stop manufacturer.

In addition to providing fire-resistance, the fire stop systems shall also be gas and watertight.

3. Product and Manufacturer: Provide one of the following:
   a. 3M Fire Stop Systems by 3M Incorporated.
   b. Or equal.

G. Miscellaneous Materials and Accessories:
1. Adhesive for Bonding Insulation: The type recommended by the insulation manufacturer and complying with fire-resistance requirements.
2. Mechanical Anchors: Type and size as shown on the Drawings or, if not shown, as recommended by the insulation manufacturer for the type of application shown and condition of substrate.
3. Wire Arch Insulation Supports: Manufacturer's standard 11-gage galvanized spring-steel clip wire arches, for self-anchoring into wood joists; length as required for joist spacing.
4. Wire Mesh Insulation Support: 2-inch by 24-gage galvanized steel wire hexagonal woven mesh.
5. Safing Impaling Clips: Provide galvanized steel impaling clips complying with requirements of governing code authorities and as recommended by the insulation manufacturer for full system responsibility.
6. Protection Board: Fiberboard sheathing or heavy duty asphaltic panels as recommended by the insulation manufacturer.
7. Adhesive Tapes: Complete selection of insulation manufacturer's recommended taping materials.
8. Bitumen: Asphalt, ASTM D 449.

2.2 MIXING

A. Verify that foamed-in-place cementitious insulation shall be mixed using the quantities, proportions and the pressures required in the manufacturer’s written specifications and comply with the intended use.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which the building insulation Work is to be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 SUBSTRATE PREPARATION

A. Verify that surfaces to receive building insulation are clean of all debris, dirt and other contamination before installation begins in any area.

3.3 INSTALLATION

A. General:
   1. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to site conditions, submit to ENGINEER specific recommendations from manufacturer for approval before proceeding with the Work.
   2. Extend all insulations full thickness over entire surface to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation.
   3. Apply the number of layers of insulation specified, each of the required thickness, or the required thickness to provide the thermal value indicated, unless otherwise shown on the Drawings or required, to make up the total thickness.

B. Unit-Type Building Insulation:
   1. Apply insulation units of the type shown on the Drawings to the substrate by the method indicated. If not otherwise indicated and except for units resting on horizontal surfaces, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
   2. Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant, of the type recommended by the manufacturer, to the edge of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.
   3. Exercise extreme care to avoid damage and soiling of faces on insulation units which will remain exposed-to-view. Align joints accurately, with adjoining surfaces set flush.
   4. Set vapor barrier faced units with vapor barrier to warm side of construction, (usually toward inside), except as otherwise shown on the Drawings. Do not obstruct ventilation spaces, except for firestopping.
   5. Tape joints and ruptures in vapor barriers, using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction so as to ensure vapor-tight installation of the units.
   6. Set reflective foil-faced units accurately with air space in front of foil as shown on the Drawings. Provide not less than 0.75-inch air space wherever possible.
   7. Support under floor blanket insulation with vapor barrier up (if any). In wood frame construction, support by continuous wire mesh stapled to bottom of joists, or on wire arches impaled into joist walls, at 12-inch spacing near bottom of joists; or provide type of blanket insulation which has permeable kraft paper face with nailing flanges.

C. Loose-Type Insulation:
   1. Pour granular insulation into spaces and onto surfaces as shown on the Drawings to completely fill all void spaces. Screed horizontal applications to uniform thicknesses shown.
   2. Place loose fiber insulation into spaces and onto surfaces as shown on the Drawings, either by pouring or by machine-blowing. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but not excessively compacted.

3. Stuff loose mineral fiber insulation into miscellaneous voids and cavity spaces as indicated. Compact to approximately 40 percent of normal maximum volume (to a density of approximately 2.5 pounds per cubic foot).

D. Safing Insulations and Fire Stop Systems:
   1. Install safing insulation and fire stop systems to present a continuous fire-rated fire barrier in areas shown on the Drawings and at the perimeter of all fire-rated partitions and poke through floor and wall penetrations to maintain the continuity of fire-rated construction whether or not shown.
   2. Install fire stop sealants and other fire stop system components in thicknesses recommended by the manufacturer at all locations where poke through penetrations occur, at all locations where other penetrations such as ducts, pipe cables, cable trays and conduit occur and at the perimeter of all fire rated walls.
   3. Include all components of manufacturer's fire/smoke stop systems for complete system responsibility installed in accordance with manufacturer's written recommendations and specifications.

E. Board-Type Perimeter Insulation:
   1. Install perimeter insulation after concrete footings have been poured and before on-grade concrete slab work begins.
   2. Remove projections which interfere with placement.
   3. Apply a single 2 foot-0 inch-wide continuous band of insulation of the required thickness and number of layers at all slab-on-grade buildings whether or not shown on the Drawings. Stagger joints between layers of insulation and butt insulation tightly together.
   4. Protect top surface of horizontal insulation from damage during concrete work by application of protection course material recommended by the insulation manufacturer.
   5. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type adhesive recommended by manufacturer of board-type perimeter insulation.
   6. Tape bottom edge of insulation before temporarily attaching insulation to wall with mastic.
   7. Tape all joints in vertical wall insulation.
   8. Protect insulation on vertical surfaces from damage during backfilling by application of protection course material recommended by the insulation manufacturer. Set in adhesive in accordance with the recommendations of the manufacturers of the insulation and the protection course material.

F. Cavity Wall Rigid Insulation Board:
   1. Install exterior wall rigid insulation board after all concrete unit masonry Work is complete.
   2. Apply a single layer of insulation cut to fit snugly and uniformly and in continuous contact with edges of continuous masonry horizontal joint reinforcement over the entire plane of the wall.
   3. Apply exterior wall rigid insulation to exterior concrete unit masonry walls in all areas shown on the Drawings to receive masonry outer cavity wall wythes.
   4. Set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of board-type cavity wall insulation.

G. Batt-Type Insulation:
   1. Install batt insulation above ceilings and between studs and rafters as shown on the Drawings. Extend insulation full width, length and height in all areas shown on the Drawings.
   2. Fit tightly around obstructions to form a uniform insulated barrier.

H. Loose Fill Insulation:
   1. Pour granular insulation into spaces and onto surfaces to completely fill all void spaces.
   2. Screed horizontal applications to uniform thickness.

I. Foamed-In-Place Cementitious Insulation:
   1. Coordinate, locate and prepare access holes large enough to accommodate compressed air foamed-in-place insulation installation hose, at 4 foot - 0 inch centers each way.
   2. Using manufacturer's recommended compressed air application equipment, fill all cavities completely; plug holes with non-shrink mortar or wood plugs level with face of substrate after verifying that foamed-in-place cementitious insulation has completely filled cavity space level with injection portal.

J. Plaza Deck Insulation:
   1. After elastic membrane waterproofing Work has been installed, install plaza deck insulation following insulation manufacturer's written specifications.
   2. Protect top surface of horizontal insulation from damage during crushed stone placement Work by application of protection course material recommended by the insulation manufacturer.

3.4 PROTECTION

A. All components of the Work shall be protected from detrimental weather conditions and until construction operations including, but not limited to, backfilling, framing and sheathing, siding and concrete masonry unit Work, is completed and acceptable to ENGINEER.

B. Work which cannot for reasons acceptable to ENGINEER be covered with complete construction system before onset of weather detrimental to the Work, shall be completely covered and protected in such a manner as to deflect precipitation from the installation without damaging adjacent Work.

C. Protect building insulations from all damage and abuse from all other contractors and installers involved on the site until Final Acceptance by OWNER.

3.5 FIELD QUALITY CONTROL

A. Foamed-In-Place Cementitious Insulation: Conduct a timed, field density check at the beginning, middle and end of each days application. Check shall be done in accordance with manufacturer's instructions and a log of results maintained and submitted to ENGINEER on a daily basis.

B. In order to ensure that foamed-in-place insulation has been installed in a continuous layer completely insulating all areas of the wall or roof, infrared thermographic

testing shall be performed at the completion of the insulation Work before beginning foamed-in-place insulation Work on adjacent areas, at no additional cost to OWNER.

C. Submit results of all testing to ENGINEER along with recommendations for remedial Work. Do not delay job progress. Coordinate the submission of tests and remedial Work in a manner which does not impact the acceptability of substrate and which permits expeditious completion of finishing Work.

3.6 ADJUSTMENT AND CLEANING

A. System components which are dislodged, damaged, expanded, broken, penetrated, or crushed by subsequent installation operations or damaged by detrimental weather shall be immediately replaced with undamaged material in compliance with the Specifications and properly protected as specified.

B. Where testing indicates that foamed-in-place building insulation has not completely filled areas to be insulated, provide remedial Work to completely fill such areas, and retest.

C. Only the original installer shall repair or replace deteriorated or defective Work.

3.7 INSPECTION AND ACCEPTANCE

A. Do not allow construction traffic which is not associated with the installation of building insulation in the area of Work. Protect the area from access by other installers and contractors until the Work of this Section has been incorporated into finished construction systems.

B. Building insulations which have become wet, damaged, or deteriorated shall be promptly removed from the site and replaced with materials conforming to the requirements of this Section.

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SECTION 07 22 00

ROOF INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all roof insulation.
   2. Extent of each type of roof insulation is shown on the Drawings.
   3. Types of products required include the following:
      a. Extruded, pentane isomer blown, polyisocyanurate rigid board-type insulation.
      b. Composite system of lightweight vermiculite insulating concrete with integral expanded polystyrene, rigid foam insulation board.
      c. Miscellaneous materials and accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the roof insulation.
   2. All framing for openings, edge angles, nailers, curbs and other items shall be in place before start of roof insulation Work.
   3. Coordinate finish of galvanized steel metal roof deck for acceptance by composite roof insulation manufacturer.
   4. Field-verify location of all roof penetrations, drain locations, and deck deflections.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Roof insulation Work shall be performed by the installer of the associated roofing for undivided responsibility.
   2. Engage a single composite roof insulation system installer, approved, in writing, by the manufacturer of the composite roof insulation, who has qualified for appointment and has been trained by the manufacturer of the composite roof insulation system and who is equipped to perform workmanship in accordance with both the requirements of the composite roof insulation manufacturer and the membrane roof manufacturer so that there will be undivided responsibility for the performance of the composite roof insulation Work.
   3. Submit proof of acceptability of installer by manufacturer to ENGINEER.

B. Source Quality Control:
   1. Obtain extruded polyiscoyanurate rigid board-type insulation from manufacturers who manufacture specified insulation using a blowing agent containing no chlorine-based compounds.
   2. Engage a single manufacturer for each type of roofing insulation who shall provide the services of a technical representative to assist CONTRACTOR and

ENGINEER by providing technical opinions on the adequacy of materials and methods of installation based on Shop Drawings approved by ENGINEER.

3. Provide such services during the time of delivery, storage, handling and installation of all roofing insulation.
4. The thicknesses shown on the Drawings are based on the thermal conductivity, k-value at 75°F specified for each material. Thicknesses of roof insulation materials submitted by CONTRACTOR as “equal” to specified materials shall have their thicknesses adjusted to provide the same thermal resistance as materials specified.

C. Erection Tolerances: Provide the following for composite roof insulation:
   1. In addition to filling the space between all metal deck flutes, provide minimum of 1/8-inch of insulating concrete over the top of the metal deck.
   2. Finished system shall not pond water and shall provide a uniformly sloped surface to low point roof drains. If at any time up to the time of final acceptance the roof shows signs of ponding water, the composite roof insulation system shall be repaired to provide uniform slope to drain at no additional cost to OWNER.

D. Requirements of Regulatory Agencies: Comply with fire-resistance ratings as required by governing authorities and the Phoenix Building Code, and comply with the following roof insulation requirements:
   1. Underwriters Laboratories requirements for roof deck constructions which are rated "UL Class A".
   2. Factory Mutual requirements for "Class 1-90" rated construction, for wind resistance.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 150, Specification for Portland Cement.
   2. ASTM C 177, Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   3. ASTM C 203, Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
   4. ASTM C 272, Test Method for Water Absorption of Core Materials for Structural Sandwich Construction.
   5. ASTM C 303, Test Method for Density of Preformed Block-Type Thermal Insulation.
   6. ASTM C 495, Test Method for Compressive Strength of Lightweight Insulating Concrete.
   7. ASTM C 518, Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of Heat Flow Meter Apparatus.
   8. ASTM C 550, Test Method for Measuring Trueness and Squareness of Rigid Block Thermal Insulation.
   9. ASTM C 1289, Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   10. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C.
   11. ASTM D 1621, Test Method for Compressive Properties of Rigid Cellular Plastics.

12. ASTM D 1622, Test Method for Apparent Density of Rigid Cellular Plastics.
13. ASTM D 1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
14. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
15. ASTM E 96, Test Methods for Water Vapor Transmission of Materials.
16. Factory Mutual Publication, Loss Prevention Data for Roofing Contractors, 1-29, Above-Deck Roof Components.
17. Factory Mutual Publication, Approval Guide.
18. Underwriters Laboratories, Building Materials Directory.
19. Phoenix Building Code.
20. Phoenix Energy Conservation Code.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each fastener to be used in the Work.
   2. 12-inch by 12-inch sample of specified extruded and expanded rigid board-type insulation and composite insulation system. Comply with the requirements of Section 01 33 23.15, Samples.

B. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for each type of roof insulation required. Include data substantiating that the materials comply with specified requirements. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
   2. Weights of all equipment to be used on roof.
   3. Field verified locations of all roof penetrations, drain locations, and deck deflections.
   4. Complete layout of all roof insulation showing sizes, placement, number of courses and methods of fastening. Include statement that fastening method, location and density of fasteners have been approved by roof membrane manufacturer and complies with wind uplift requirements specified.
   5. All required roof insulation details approved by the roof insulation manufacturer and the manufacturer of the respective roofing systems.
   6. Laboratory test results for thermal resistance values based on ASTM C 177 or ASTM C 518 for actual composite roof insulation system shown on the Drawings and specified.

C. Certifications: Submit Job Conditions Report, prepared by composite roof insulation installer, as specified, and in addition, include a notarized statement from the full-time on-site technical representative and installer that the composite roof insulation system was installed according to manufacturer's written recommendations as shown on approved Shop Drawings.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Do not deliver insulation materials to the site before time of installation.

2. Deliver materials in manufacturer's original, undamaged packages or acceptable bulk containers. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage and Handling of Materials:
   1. Do not allow insulation materials to become wet or soiled.
   2. Protect plastic insulation from exposure to sunlight.
   3. Protect plastic insulation against ignition.
   4. Store packaged materials to protect them from the weather and physical damage.
   5. Comply with manufacturer's recommendations for handling, storage and protection.
   6. Do not use cement which shows indication of moisture damage, caking or other signs of deterioration.
   7. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

1.5 JOB CONDITIONS

A. Pre-Roofing Meeting: Provide both a representative of the composite roof insulation system manufacturer and the foreman of the installer who will actually work on this project at the Pre-Roofing Meeting specified in Section 07 50 00.

B. Environmental Requirements:
   1. Do not install roof insulation when weather conditions are such that the deck is not completely dry, or where there is no assurance that the roof insulation can be completely protected from the weather by the end of the day's work.
   2. For applications of composite roof insulation system, when the temperature is expected to fall below 40°F, submit written installation recommendations of the composite insulation system manufacturer confirming acceptability of the conditions encountered. Verify that composite roof insulation system installed under such adverse weather conditions meet all material and performance requirements specified. Installer shall record actual conditions of installation, including intervals between system component placement, weather and temperature conditions, temporary uses of roof (if any) and other pertinent installation factors and include in Job Conditions Report submitted to ENGINEER.
   3. Hot water is not available at the site and shall be supplied by composite roof insulation installer as required by installation conditions.
   4. Potable water is not available at the site and shall be provided by composite roof insulation installer.

C. Protection:
   1. Do not overload the building structure with the weight of stored materials or use of equipment.
   2. Install temporary water cut-offs at the end of each day's work to protect the roof insulation. Remove the temporary water cut-offs upon resumption of the Work.

D. Sequencing:
   1. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the roof

insulation are at the site and are ready to follow with this Work immediately (same day) after the roof insulation Work.

2. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the insulation are at the site; are installing the vapor barrier, and are ready to follow with this Work immediately (same day) behind the roof insulation Work.
3. Do not install any more rigid board-type roof insulation each day than can be covered with complete roofing system by the end of that working day.
4. Follow composite roof insulation manufacturer's written requirements for installation timing and sequencing of Work. Do not place more leveling slurry coat than can be completely covered with insulation within thirty minutes nor more expanded polystyrene insulation than can be covered with insulating concrete within four hours of placing insulations.

1.6 GUARANTEE

A. The manufacturer of the composite roof insulation system shall warrant to OWNER that the roof insulation will remain in a re-roofable condition, for a period of ten years, should the roof membrane require replacement; that the roof insulation will remain in place even if the roof membrane sustains wind damage; and that the roof insulation's actual resistance to heat flow will be at least 80 percent of the installed value, provided the roof remains leak free.

1.7 SUBSTITUTIONS

A. Manufacturer of the primary roofing membrane systems shall be manufacturers who find the generic types of insulation specified herein as acceptable and bondable if installed according to the roofing manufacturer's standards for complete product and performance responsibility.

B. The thickness of the composite roof insulation system, the maximum step between layers of expanded polystyrene rigid board insulation, and the minimum slope-to-drain requirements shall not vary from what is shown on the Drawings, specified and approved.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Extruded Polyisocyanurate Rigid Board Roof Insulation:
   1. Rigid, rectangular boards of extruded closed-cell polyisocyanurate complying with ASTM C 1289, Type II, with low water vapor permeability and laminated to heavy black (non-asphaltic) fiber-reinforced felt facers with one side of board containing perforated facers and the other side containing non-perforated facers.
   2. Provide a blowing agent with zero ozone depletion potential, such as pentane.
   3. Physical Properties: Provide the following:
      a. Minimum Compressive Strength, (at ten percent deformation), ASTM D 1621: 25 psi minimum.
      b. Flame Spread, ASTM E 108: Class A.

c. Smoke Development, ASTM E 84: 120 maximum.
d. Vapor Transmission, ASTM E 96: 0.8 perms/inch.
e. Thermal Resistance, ASTM C 518: 7/inch.
f. Maximum Water Absorption, ASTM C 209: 0.10 percent by volume.

4. Size: 48-inches by 96 inches by 2-inch thick.
5. Number of Layers: As required by thickness of roof insulation shown on the Drawings.
6. Product and Manufacturer: Provide one of the following:
   a. ACUltra (Pentane Blown) Hydrocarbon ACFoam - II by Atlas Roofing Corporation.
   b. Or equal.

B. Composite Roof Insulation:
   1. Expanded Polystyrene Rigid Board: Provide the following board as a system component of the composite roof insulation system for use beneath all membrane roofing:
      a. Rigid: 100 percent virgin expand polystyrene modified resin bead board with bead fusion of 80 percent minimum with no visible voids.
      b. Molded blocks air dried for minimum of six weeks with less than 0.5 percent residual pentane prior to fabrication.
      c. Size: 24-inches by 48-inches with pattern of 30 holes and 30 slots per board.
      d. Dimension Tolerances, ASTM C 550:
         1) Length: ±1/16-inch.
         2) Width: ±1/16-inch.
         3) Thickness: ±1/16-inch.
         4) Squareness: ±1/16-inch.
         5) Flatness: ±1/32-inch.
      e. Physical Properties:
         1) Density, ASTM C 303: 1.15 to 1.25 lbs/cu.ft.
         2) Thermal Resistance, (R at 75°F), ASTM C 177 and ASTM C 518: R = 3.85 s.f./°F/hr/BTU.
         3) Thermal Conductivity (k at 40°F), ASTM C 177 and ASTM C 518: U-0.25 BTU/in. hr/s.f./°F.
         4) Coefficient of Thermal Expansion, ASTM D 696: 3.5 x 10-5 in./in./°F.
         5) Compressive Strength (ten percent deflection), ASTM D 1621: 13 to 17 psi.
         6) Flexural Strength, ASTM C 203: 28 to 35 psi.
         7) Tensile Strength, ASTM C 1623: 16 to 20 psi.
         8) Water Vapor Transmission, ASTM E 96: 1.2 to 2.2 perms.
         9) Water Vapor Adsorption, ASTM C 272: Less than 2 percent.
         10) Flame Spread, ASTM E 84: 5.
         11) Smoke Developed, ASTM E 84: 40 to 85.
      f. Thickness: Varies from 2-inch thick rigid board at low points to thickness required by high point elevations shown.
   2. Insulating Concrete: Provide the following:
      a. Portland Cement: ASTM C 150, Type I, II or III.
      b. Vermiculite Aggregate: As recommended by system manufacturer.
      c. Calcium Chloride: Not permitted.
      d. Water: Potable, clean, and free from deleterious amounts of acid, alkali and organic materials.

e. Physical Properties: Provide the following physical properties for the insulating concrete design mix:
1) Minimum Compressive Strength, ASTM C 495: 300 psi.
2) Density at Placement: 60 to 68 pcf.
3) Oven Dry Density: 33 to 42 pcf.

3. Reinforcing Mesh: 2160-2-1619 galvanized mesh as recommended by the manufacturer of the composite roof insulation.
4. Product and Manufacturer: Provide one of the following:
a. NVS and Insulperm Polystyrene Roof Insulation System by Siplast Incorporated.
b. Or equal.

C. Miscellaneous Materials:
1. Adhesive for Bonding Insulation: The type recommended by the roof insulation manufacturer, and complying with fire-resistance requirements.
2. Mechanical Anchors: The type recommended by the roof insulation manufacturer for the type of deck used, and complying with fire and insurance rating requirements.
3. Mastic Sealer: Type recommended by roof insulation manufacturer for bonding edge joints between units and filling voids.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which the roof insulation Work is to be performed, and notify ENGINEER, in writing, of any unsatisfactory conditions. Do not proceed with the roof insulation Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Commencement of the Work shall be understood by ENGINEER to mean that all conditions are acceptable to both the manufacturer's technical representative and CONTRACTOR to provide acceptable Work under this Contract.

3.2 PREPARATION

A. Verify that fire-resistant roof insulation underlayment boards are in place on sloping metal decks and has been installed according to the requirements of FM Approval Guide.

B. For metal roofing verify that metal purlins and continuous wood sleepers are properly installed over all areas to receive metal roofing Work.

C. Verify that vapor barrier has been installed on decks, with all joints and penetrations in the vapor barrier sealed using techniques recommended by the vapor barrier manufacturer to retain full perm rating of the vapor barrier.

3.3 INSTALLATION

A. General:
   1. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to site conditions, consult manufacturer's technical representative for specific recommendations before proceeding. Incorporate recommendations into the Work only as approved by ENGINEER.
   2. Coordinate heights of wood blocking to provide flush transition between roof insulation and perimeter wood blocking.
   3. Extend roof insulation full thickness as shown on the Drawings over entire surface to be insulated.
   4. Cut and fit tightly around obstructions, and fill voids with roof insulation. Refer to and comply with the requirements of Section 06 10 00, Rough Carpentry, Section 07 50 00, Single Ply Membrane Roofing.

B. Board-Type Roof Insulation Units: Install rigid board-type roof insulation according to FM 1-29 Wind Storm Resistance Classification specified, and as follows:
   1. Install wood nailers as required by roofing membrane manufacturer.
   2. Prime surface of concrete deck with asphalt primer at the rate of 3/4 gallons per 100 square feet, unless greater weight is required by roofing membrane system manufacturer, and allow primer to dry. Set each layer of roof insulation in a solid mopping of hot roofing asphalt.
   3. Secure first layer or roof insulation to deck using mechanically fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type shown and in accordance with the requirements of applicable governing authorities and roofing membrane manufacturer's recommendations, whichever produces the greatest fastener density.
   4. Apply two courses of roof insulation to make up the total required thickness under roofing.
   5. Install rigid board-type roof insulation to form a continuous, uninterrupted plane between metal purlins installed perpendicularly to slope of metal deck, with all roof insulation boards tightly butted together. Align top of roof insulation boards flush with top surface of metal purlins or as shown on the Drawings for ventilated metal roof assemblies.
   6. Stagger the short-side edges of roof insulation board in one direction with the two opposite sides of each roof insulation board continuously supported on steel deck ribs, as close as possible to the center of the rib as practical, and with a minimum bearing width of 1-inch. Trim board edges if they veer off the rib center. Stagger joints in each succeeding layer from joints of previous layer a minimum of 6-inches in each direction.
   7. Coat edges of closed-cell (non-breathing) units with either adhesive or mastic sealer, and shove into place against installed units so that joints are filled and sealed.
   8. Extend roof insulation full thickness as shown on the Drawings over entire surface of roofs.

C. Composite Roof Insulation System:
   1. Place insulating concrete using approved equipment after sufficient mixing time to provide a consistent, thoroughly uniform consistency that will screed to a

smooth surface and achieve the compressive strength specified in a cement to aggregate ratio of 1:3.5 per cubic foot.

2. Fill metal deck corrugations with insulating concrete slurry to a level 1/8-inch above the top of the corrugations.
3. Place expanded polystyrene rigid board insulation into the slurry within thirty minutes of insulating concrete placement with joints staggered in a running bond pattern.
4. Tightly butt all rigid boards together and install in a manner that provides full contact of slurry to board, and with adequate pressure to cause insulating concrete to enter the locking/keying openings of the rigid board.
5. Install rigid boards in a stair-stepped configuration with maximum step down of 1-inch between boards, over entire plane of roof surface. Cut boards as required in order to maintain 2-inches of insulating concrete cover at insulation step in compliance with slope-to-drain and high point and low point elevations shown.
6. Within four hours of rigid board placement, place 2-inches of insulating concrete over rigid boards and screed to a smooth, consistently dense, uniformly sloped plane to roof drains at low points. Ensure that all locking/keying openings in rigid board are completely filled with insulating concrete. Provide finish and other system features acceptable to membrane roofing installer.
7. Include reinforcing mesh as part of the composite roof insulation system to help control crack formation and distribute forces within the composite roof insulation system.
8. Provide high and low point elevations as shown on the Drawings. Provide smooth, uniformly sloped top of insulating concrete plane, sloped to drain at 1/4-inch per foot.

3.4 PERFORMANCE

A. Roof insulation Work shall withstand the uplift forces of wind, as defined by the Roofing Guarantee.

B. Failures of the roof insulation Work in bond or anchorage to the substrate, or between courses of roof insulation, or within the roof insulation, will be considered failures of materials or workmanship under the Roofing Guarantee.

C. Failures of the composite roof insulation Work in bond or anchorage to the substrate, or within the roof insulation, will be considered failures of materials or workmanship under the insulation performance warranty.

3.5 FIELD QUALITY CONTROL

A. Test the substrate for moisture content, by suitable means, wherever there is a possibility that exposed substrate has acquired moisture in excess of the maximum content for optimum application of the insulation, as determined by the manufacturer.

3.6 PROTECTION

A. Do not permit construction traffic over completed insulation Work, except as required for roofing.

B. Protect roof insulation Work from exposure to moisture, damage and deterioration, primarily by prompt installation of roofing Work to be placed over the roof insulation.

C. Do not expose completed composite roof insulation Work to prolonged exposure to elements in excess of seven days.

D. Do not use completed composite roof insulation as a temporary working surface without protection approved by composite roof insulation installer, or as a temporary roofing system.

3.7 COMPOSITE ROOF INSULATION FIELD TESTING

A. Check cast density hourly at the point of placement. Include reports as part of information and submit to ENGINEER.

B. Retain a minimum of four 3-inch by 6-inch cylinder material specimens for each day's pour. Protect specimens from damage and temperature extremes and test in accordance with ASTM C 495. Submit results of test to ENGINEER.

3.8 INSPECTION AND ACCEPTANCE

A. Roof insulation which has become wet, damaged, or deteriorated, as determined by ENGINEER, shall be promptly removed from the site, even if already installed.

B. Correct all improperly sloped, chipped, cracked, improperly set, ridged or rough areas in the roof insulation to provide substrate acceptable to roofing manufacturer and ENGINEER.

C. Final acceptance will be contingent upon the receipt by ENGINEER of CONTRACTOR'S certification stating conformance of the Work to the requirements of this Section, which includes all information requested by the Specifications.

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SECTION 07 24 00

EXTERIOR INSULATION AND FINISH SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, appurtenances, specialty items and services required to furnish and install the complete exterior insulation and finish system (EIFS) Work.
   2. The extent of the exterior insulation and finish system is as shown on the Drawings and as specified herein.
   3. The types of exterior insulation and finish system Work required includes, but is not necessarily limited to, the following:
      a. A ready-mixed acrylic-based textured wall coating system including double layers of reinforcing mesh and all additives and components as recommended by the manufacturer for application over rigid insulation board.
      b. Key coats, ground coats and finish coats of reinforced plaster materials with mechanical finish specified.
      c. Double-layer reinforcing meshes and applicable matrixes for all surfaces receiving rigid insulation board to full height and width.
      d. Insulation board.
      e. All additives and miscellaneous components necessary to complete the Work.
      f. Custom fabrication of all system components as required to reproduce the architectural features shown on the Drawings to the allowable tolerances specified.

B. Coordination:
   1. The manufacturer of the materials specified herein shall be required to review and satisfy all relevant requirements of other Sections and the requirements of the Drawings. CONTRACTOR, manufacturer, supplier, fabricator and/or subcontractors furnishing and/or installing materials, equipment, services and specialties associated with this Section shall fully coordinate their efforts.
   2. Review installation procedures under other Sections and coordinate the Work to produce substrate surfaces free from contaminants incompatible with the exterior insulation and finish system Work, and substrates acceptable to the exterior insulation and finish system installer for completely acceptable product performance.
   3. Provide all labor, equipment, materials, appurtenances, specialty items and services not provided by CONTRACTOR'S manufacturers, suppliers, fabricators and/or subcontractors, but required to furnish and install the complete and operable systems.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Provide a single installer, approved by the specified EIFS manufacturer who is regularly engaged in exterior insulation and finish systems Work and has a minimum of five years experience in the installation of the types of materials specified.

B. Design Criteria:
   1. Comply with the recommendations of the Plasterer's Manual, by the Portland Cement Association; the Phoenix Building Code; and the Guideline Specification for exterior insulation and finish systems Class PB, published by EIFS Industry Members Association (EIMA), except where more stringent requirements are shown on the Drawings or specified.
   2. In order to ensure complete product compatibility and bondability of the completed exterior insulation and finish system Work, CONTRACTOR may, with the approval of the ENGINEER, submit manufacturer sub-components of the exterior insulation and finish system Work which the manufacturer certifies, in writing, to the ENGINEER, to be more appropriate to the substrate or job conditions encountered. All such approved substitutions shall be at no additional cost to the OWNER. No reduction in number of layers or types of reinforcing mesh shall be approved by the ENGINEER.
   3. Final selection of products shall be made from manufacturer's complete selection of highest quality products at no additional cost to the OWNER.
   4. A fully adhesive-based system is specified herein. Where, on new work, acceptability of substrate adhesive bond cannot be determined or made acceptable to the exterior insulation and finish system installer, provide exterior insulation and finish system manufacturer's standard sheathing dowel system for the Work of this Section.
   5. Test Reports: Furnish to the ENGINEER certified laboratory test reports from the manufacturer for required performance tests as follows:
      a. Surface Burning Characteristics Test in accordance with ASTM E 84.
      b. Water Penetration Test in accordance with ASTM E 331, EIMA 101.02.
      c. Wind Load Test in accordance with ASTM E 330.
      d. Impact Resistance Test in accordance with EIMA 101.86.
      e. Abrasion Resistance Test in accordance with ASTM D 968.
      f. Accelerated Weathering Tests in accordance with ASTM G 152, ASTM G 153, and ASTM G 154.
      g. Mildew Resistance Test in accordance with ASTM D 3273.
      h. Water Resistance Test in accordance with ASTM D 2247.
      i. Absorption - Freeze/Thaw Tests in accordance with ASTM C 67, EIMA 101.01.
   6. Certification: Furnish to the ENGINEER certification that all materials are compatible with substrates as specified.

C. Allowable Tolerances:
   1. Flat or Curved Surfaces: Do not exceed 1/8-inch in eight feet for bow or warp of surface, and for plumb or level.
   2. Color Breaks: Do not exceed 1/8-inch in eight feet out-of-alignment from color break lines shown on the Drawings.

D. Source Quality Control: Obtain all materials from the same manufacturer and provide the following:
   1. Provide the services of a qualified manufacturer's technical representative at the project site at the commencement of Work and during the time when the mock-up Work is being constructed to advise on materials, installation and finishing techniques.

E. Job Mock-Ups:
   1. Prior to the installation of the exterior insulation and finish system Work, but after ENGINEER'S approval of Shop Drawings, build free-standing 4 foot by 6 foot sample panels of each type of complete exterior insulation and finish system on same substrate material that will be used in the Work, to show a representative installation of each complete exterior insulation and finish system Work, including final texture and colors. Stage sample panel Work to leave exposed a 12-inch wide band of each component required in the Work. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of exterior insulation and finish system Work. Retain and protect mock-up during installation as a standard for judging completed exterior insulation and finish system Work. Do not destroy mock-up until given permission by the ENGINEER.
   2. Exterior insulation and finish system Work that does not meet the standard approved on the sample areas shall be removed and replaced by CONTRACTOR at CONTRACTOR'S expense.
   3. Job Mock-ups that do not have an exposed portion of each system component shall be rejected.

F. Pre-Installation Meeting:
   1. Prior to the installation of the exterior insulation and finish system, (including installation of any sheathing board, insulation and associated Work) schedule and attend a Pre-Installation Meeting to review the following.
      a. Review project requirements, including all Contract Documents.
      b. Procedure for on-site inspection and acceptance of EIFS substrate and pertinent details (for example, mock-up installation).
      c. CONTRACTOR'S plan for the coordination of Work of the various trades involved in providing EIFS and other components.
   2. Pre-Installation Meeting shall be attended by CONTRACTOR, EIFS manufacturer's technical representative, personnel directly responsible for installation of the EIFS system, personnel responsible for related work, such as flashing, windows and doors, and the ENGINEER. Before beginning EIFS Work, confirm, in writing, the resolution of conflicts among those attending the Pre-Installation Meeting.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
   3. ASTM C 67, Test Methods for Sampling and Testing Brick and Structural Clay Tile.
   4. ASTM C 150, Specification for Portland Cement.

5. ASTM C 177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
6. ASTM C 203, Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
7. ASTM C 272, Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
8. ASTM C 303, Test Method for Dimensions and Density of Preformed Block-Type Thermal Insulation.
9. ASTM C 518, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
10. ASTM C 550, Test Method for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation.
11. ASTM C 578, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C 847, Specification for Metal Lath.
13. ASTM C 1177, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
14. ASTM C 1186, Specification for Flat Non-Asbestos Fiber-Cement Sheets.
15. ASTM C 1382, Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints.
16. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30ºC and 30ºC With a Vitreous Silica Dilatometer.
17. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
18. ASTM D 1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
19. ASTM D 1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
20. 20 ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
21. ASTM D 3273, Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
22. ASTM E 72, Test Methods of Conducting Strength Tests of Panels for Building Construction.
23. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
24. ASTM E 96, Test Methods for Water Vapor Transmission of Materials.
25. ASTM E 330, Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
26. ASTM E 331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
27. ASTM G 152, Practice for Operating Open Flame Carbon Arc light Apparatus for Exposure of Nonmetallic Materials.
28. ASTM G 153, Practice for Operating Enclosed Carbon Arc light Apparatus for Exposure of Nonmetallic Materials.
29. ASTM G 154, Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
30. Phoenix Building Code.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Manufacturer's complete selection of standard and custom colors and textured finish coats. Comply with the requirements of Section 01 33 23.15, Samples.
   2. Each component material to be used in the Work.
   3. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for each component of the exterior insulation and finish systems for each substrate.
   2. Fully coordinated Shop Drawings showing 1/4-inch scale elevation of all walls to receive the Work of this Section and all termination details at 1-1/2-inch scale between this Work and the work of other Sections. Also, include details of system components and control joint locations and details and all custom architectural shapes required for the Work.
   3. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

C. Test Reports: In accordance with Paragraph 1.2.B.5., above, of this Section.

D. Certification: In accordance with Paragraph 1.2.B.6., above and Paragraph 3.4.B., below, of this Section.

E. Warranty: In accordance with Paragraph 1.6.A., below, of this Section.

F. Maintenance Manual: Submit copies of bound maintenance manual for the exterior insulation and finish system Work. Include instructions for cleaning, repair and general maintenance Work. Include manufacturer's data on all components of the exterior insulation and finish system Work and name, address and telephone number of manufacturer, installer and local product distributor. Comply with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in exterior insulation and finish system manufacturer's original unopened packages. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufacture.
      c. Mixing instructions, shelf life and curing time, when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER, and require its removal from the site. Supply new material conforming to the specified requirements at no additional cost to OWNER.

B. Storage and Handling of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Store in accordance with manufacturer's recommendations in a clean, dry, well-ventilated area.
   3. Store materials out of direct sunlight and at a temperature of not less than 40ºF.
   4. Handle materials carefully to prevent inclusion of foreign materials.
   5. Do not open containers or mix components until necessary preparatory Work has been completed and installation will start immediately.
   6. Do not expose combustible or sensitive material to excessive heat or open flame.
   7. Materials shall be used in the Work only when the material being incorporated into the Work bears the same name and formulation as the container or package in which it is contained.
   8. Do not change containers or use material from unmarked or incorrectly labeled containers.
   9. Failure to comply with this requirement will be cause for the ENGINEER to require the product to be removed from the site and the area wherein the product has been incorporated to be removed and rebuilt with material complying with the specified requirements. This requirement shall govern even if CONTRACTOR certifies or proves that the material was appropriate for incorporating into the Work.
   10. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Proceed with the exterior insulation and finish system Work only when weather conditions will permit unrestricted use of materials and quality control of the Work being installed, complying with the Specification requirements and with the recommendations of the exterior insulation and finish systems materials manufacturer.
   2. Do not proceed with the installation of exterior insulation and finish system under adverse weather conditions, or when temperatures are below 40°F or expected to fall below 40°F within 24 hours after installation.
   3. Do not apply in hot sun or on heated walls, unless walls are cooled first by hosing with clean water until cool.
   4. Under extremely windy or hot conditions, where too rapid drying occurs, cure finished surface by fog spraying with water. Comply with manufacturer's recommendations to prevent color variation.
   5. Proceed only when CONTRACTOR and his installer are willing to guarantee the Work as required and without additional reservations and restrictions.

B. Scheduling:
   1. Proceed with the exterior insulation and finish system Work only after all sheathing board, insulation and framing for projections through the substrate construction are completed.
   2. Proceed with and complete the Work only when materials, equipment and workers required for the installation of the exterior insulation and finish system Work are at the site and have sufficient materials and resources to complete the Work in a manner which shall reveal no inconsistencies of texture, color or

allowable tolerance in the finished Work greater than that which has been approved on the sample panel by ENGINEER.

C. Protection:
1. Do not allow finish system Work to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining materials.
2. Draw all color break lines accurately and to the tolerances specified.
3. Protect materials against damage by construction traffic.

1.6 WARRANTY

A. Furnish an additional written warranty signed by the manufacturer, installer and CONTRACTOR, agreeing to replace exterior insulation and finish system Work which fail in materials or workmanship within five years of the date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulation Board: Provide the following:
1. Rigid: 100 percent virgin expandable polystyrene modified resin bead board in compliance with ASTM C 578, Type I, with bead fusion of 80 percent minimum with no visible voids.
2. Molded blocks air dried for minimum of six weeks with less than 0.5 percent residual pentane prior to fabrication.
3. Dimension Tolerances, ASTM C 550:
a. Length: ±1/16-inch.
b. Width: ±1/16-inch.
c. Thickness: ±1/16-inch.
d. Squareness: ±1/16-inch.
e. Flatness: ±1/32-inch.
4. Physical Properties:
a. Density, ASTM C 303: 0.91 to 1.10 lbs/cu.ft.
b. Thermal Resistance, (R at 75°F), ASTM C 177 and ASTM C 518: R=3.6 s.f./°F/hr/BTU.
c. Thermal Conductivity (k at 40ºF), ASTM C 177 and ASTM C 518: U=0.25 BTU/in.hr/s.f./°F.
d. Coefficient of Thermal Expansion, ASTM D 696: 3.5×10^{-5} in./ in./°F.
e. Compressive Strength (ten percent deflection), ASTM D 1621: 10 to 14 psi.
f. Flexural Strength, ASTM C 203: 25 to 30 psi.
g. Tensile Strength, ASTM C 1623: 16 to 20 psi.
h. Water Vapor Transmission, ASTM E 96: 2.0 to 5.0 perms.
i. Water Vapor Absorption, ASTM C 272: Less than four percent.
j. Flame Spread, ASTM E 84: Less than 25.
k. Smoke Developed, ASTM E 84: Less than 450.
5. Thicknesses: 1-inch, 2-inch and as required to provide architectural features shown on the Drawings.

6. Rigid insulation shall be as approved by the exterior insulation and finish system manufacturer for complete product system responsibility.
7. Where insulation board is shown on the Drawings with non-standard profiles provide custom fabricated rigid polystyrene resin boards fabricated to the profiles shown on the Drawings, complying with the tolerances specified. Provide continuous pre-molded inside and outside corner shapes.
8. Provide insulation boards approved by the exterior insulation and finish system manufacturer for the system specified herein.

B. Primers: Provide non-staining, quick-drying primers and sealers for the substrate encountered as recommended by the manufacturer of the complete exterior insulation and finish system:

C. Adhesives: Provide adhesives as required for the substrate encountered as recommended by the manufacturer of the complete exterior insulation and finish system:

D. Reinforcing Meshes: Provide the following two types:
   1. Heavy Duty, High Impact Reinforcing Mesh:
      a. Nominal 15 oz./sq.yd. Alkali-resistant glass fiber double strand interwoven mesh made from twisted multi-end strands.
      b. Glass fibers coated with a minimum of 20 grams of styrene butadiene per square yard.
      c. Product and Manufacturer: Provide the following:
         1) Armor Mat by STO Corp.
         2) Or equal.
   2. Standard Reinforcing Mesh:
      a. Nominal 4.5 oz./sq.yd. Alkali-resistant glass fiber symmetrically interlaced, made from twisted multi-end strands.
      b. Glass fibers coated with a minimum of 20 grams of styrene butadiene per square yard.
      c. Product and Manufacturer: Provide the following:
         1) Reinforcing Fiber Mesh by STO Corp.
         2) Or equal.

E. Textured Wall Finish: Provide a ready-mixed water-based co-polymer acrylic wall coating capable of achieving a uniform textured sandblast effect, containing marble aggregate, fine pigments and fillers. Comply with the following:
   1. Particle Size: 2.0 millimeter.
   2. Color: Complete selection of manufacturer's standard and custom colors. ENGINEER shall select a maximum of five different colors or tones.
   3. Texture: Textured stucco effect. Final exact texture to be selected by ENGINEER from manufacturer's complete selection of standard and custom textured finishes.
   4. Resistant to the effect of weather.
   5. Hardness: Resistant to mechanical stress. Scratch and impact resistant.
   6. Flexibility: Capable of bridging normal shrinkage cracks.
   7. Manufacturer's of "or equal" products and systems shall provide a complete selection of standard and custom colors and textures.
   8. Product and Manufacturer: Provide the following:
      a. STOLIT by STO Corp.

b. Or equal.

F. Sheathing Board: Provide glass mat gypsum sheathing boards conforming to ASTM C 1177 and as recommended by the manufacturer of the complete exterior insulation and finish system.

G. Fiber Reinforced Cement Sheathing Board: Provide fiber reinforced cement sheathing boards conforming to ASTM C 1186 and as recommended by the manufacturer of the complete exterior insulation and finish system.

H. Lathing and Furring: Provide self-furring, galvanized, lathing and furring conforming to ASTM C 847 and as recommended by the manufacturer of the complete exterior insulation and finish system.

I. Miscellaneous Materials: Provide the following:
1. Sheathing Dowels: Plastic, wing-tipped type fasteners with a thermal cap to prevent uneven thermal and vapor diffusion.
2. Water: Free from injurious amounts of impurities and potable.
3. Portland Cement: ASTM C 150, Type I.
4. Deep V Expansion Joints and Surface Mounted Control Joints: Galvanized metal, ASTM A 653, with temporary fasteners.

2.2 MIXES

A. Stir co-polymer based adhesive, ground coat and leveler following manufacturer's written instructions, prior to the addition of Type I Portland cement.

B. Add 20 percent Portland cement by weight to co-polymer based adhesive, ground coat and leveler.

C. Batch material as recommended by the manufacturer and add premeasured amounts of Portland cement slowly to co-polymer based adhesive, ground coat and leveler material.

D. Anti-freeze, accelerators and rapid binders are not allowed.

E. Primer: Mix thoroughly with ten percent by weight of clean water.

F. Air entraining agents, air entrained lime, and air entrained Portland cement are not allowed.

G. Mix only as much material as can readily be used.

2.3 FABRICATION

A. Custom fabricate exterior insulation and finish system to provide all arises, returns, reveals and architectural features shown on the Drawings.

B. Product and Manufacturer: Provide the following:
1. Heavy-duty exterior insulation and finish systems by STO Corp.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates to receive exterior insulation and finish system Work, and the conditions under which the Work is to be performed, and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the exterior insulation and finish systems. Do not proceed with the exterior insulation and finish systems Work until unsatisfactory conditions have been corrected by CONTRACTOR.

3.2 PREPARATION

A. Prime and seal all sheathing board and substrates with primer specified and coordinate fastener selection, adhesives and finishes as required by exterior insulation and finish system manufacturer.

3.3 INSTALLATION

A. General: General rules for application of finishes shall be as follows:
   1. Using a clean rust free high speed mixer, thoroughly stir finish to a uniform consistency (small amounts of clean water may be added to aid workability).
   2. Avoid application in direct sunlight.
   3. Apply finish in a continuous application always working to a wet edge.
   4. Finish may be applied over calk joints, but not over expansion joints.
   5. Apply aggregate and textured finish coats following the specified EIFS manufacturer's printed instructions.

B. Over all primed and sealed substrates shown on the Drawings as receiving insulation board:
   1. Level uneven surfaces using specified ground coat.
   2. Apply standard reinforcing mesh starter strip to the substrate at base line termination of expanded polystyrene board using specified ground coat material and following manufacturer's written instructions.
   3. Provide starter strip wide enough to adhere 4-inches of mesh onto the substrate, and be able to wrap around board edge and cover approximately 4-inches on the outside surface of the expanded polystyrene board. Follow this procedure at all exposed expanded polystyrene board edges.
   4. Using specified adhesive apply adhesive to the back of the expanded polystyrene board using a 5/8-inch notched trowel. Provide uniform ribbons of adhesive applied horizontally with the building walls.
   5. Place expanded polystyrene board horizontally on the walls starting from a level base line. Stagger vertical joints and interlock polystyrene board at all inside and outside corners.
   6. Apply firm pressure over entire surface of the boards to ensure uniform contact. Sufficient pressure must be applied to flatten the ribbons of adhesive to result in a minimum of 50 percent adhesion.
   7. Butt all joints tightly together to eliminate all thermal breaks. Prevent adhesive from getting between joints of expanded polystyrene board. Allow adhesive to cure as recommended by the manufacturer.

8. All open joints in the expanded polystyrene board layer shall be filled with an approved spray foam.
9. Rasping of the expanded polystyrene board surface shall be required to achieve a smooth even surface, remove possible ultra-violet ray damage, meet tolerances specified, and to provide architectural features shown on the Drawings.
10. At all areas where the exterior insulation and finish system Work meets dissimilar material or terminates, cut back the expanded polystyrene board from the adjoining material a minimum of 1/4-inch to form a calk joint and calk so that no water can penetrate through or behind the system. Follow manufacturer's applicable printed details. Prior to sealant installation all expanded polystyrene board edges shall be coated with ground coat and exterior insulation and finish coat and manufacturer's recommended primer.
11. Ground coat material shall be stirred to a uniform consistency. Apply ground coats, using a stainless steel trowel, to a uniform thickness of approximately 1/8-inch each. Work horizontally or vertically in strips of 40-inches, and immediately embed the heavy duty reinforcing mesh into the wet ground coat. While ground coat is still wet, totally embed the heavy duty reinforcing mesh and feather out seams and edges. The finish thickness of the ground coat shall be such that the heavy duty reinforcing mesh is fully embedded yet mesh outline may be visible.
12. Do not overlap heavy duty reinforcing mesh. Tightly abut mesh with gaps no greater than 1/8-inch at seams. Allow to dry before applying standard reinforcing mesh.
13. Using a stainless steel trowel apply another layer of specified ground coat material over the cured heavy duty reinforcing mesh application to a uniform thickness of 1/16-inch. Work horizontally or vertically in strips 40-inches wide and immediately embed the standard fiberglass mesh into this wet ground coat. Mesh shall be double wrapped at all corners and overlapped not less than 2-1/2 inches at mesh joints. Avoid wrinkles in the mesh. The finish thickness of the ground coat shall be such that the reinforced fiberglass mesh is fully embedded, yet mesh outline may be visible. Allow ground coat to thoroughly dry before applying finish. Apply finish coat directly over the ground coats with primer, only after the ground coat has thoroughly dried to provide colors and textures approved by the ENGINEER. Finish shall be applied by troweling using a clean plastic trowel, depending on finish specified as recommended by the specified EIFS manufacturer.
14. Apply tinted ground coat primer specified before finish coat Work begins. Follow the specified EIFS manufacturer's written instructions.

C. Mechanical Fasteners: Provide the following:
   1. For substrate conditions encountered install mechanical fasteners as recommended by the specified EIFS manufacturer.
   2. Spacing and selection of fasteners shall be as recommended in the specified EIFS manufacturer's written installation instructions.

D. Install backer rod (25 percent compression) in calk joint openings to provide a depth equal to the width of the joint. Install a manufacturer's approved sealant and tool flush with the ground coat surface. Allow sealant to set in accordance with the specified EIFS manufacturer's specifications prior to applying finish coat.

E. Vertical Building Expansion Joints: Vertical building expansion joints shall be installed when the substrate has an existing control joint, expansion joint, or live building crack, or where the system is applied to dissimilar substrates. These joints shall extend through the full thermal system and shall be calked with an approved expansion joint sealant against a backer rod. On expansion joints, the reinforcing fiberglass mesh and ground coat shall completely wrap the edges of the insulation board so that the expansion joint calk is not in direct contact with the insulation board.

F. Horizontal Control and Vertical Aesthetic Joints: Horizontal and vertical aesthetic joints shall be installed in accordance with the specified EIFS manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. Provide the services of a field technical representative authorized by the manufacturer of the EIFS to perform on-site, in-progress inspections at no additional cost to the OWNER.

B. Certify that the completed Work is in accordance with the Specifications and without damage or deterioration at the time of Final Acceptance.

3.5 ADJUSTMENT, CUTTING AND PATCHING

A. Cut, patch, and repair exterior insulation system and finish coat Work as required and as necessary to accommodate and provide acceptable substrate for other work. Repair cracks and indented surfaces. Point-up finish surfaces around items which are built into or penetrate exterior insulation system and finish coat Work.

B. Repair or replace the Work to eliminate blisters, buckles, check cracking, dry outs, excessive pinholes, and similar imperfections. Repair or replace the Work as necessary to comply with specified tolerances and required visual effects.

C. Protect exterior insulation and finish system Work so as to be clean and undamaged at the time of Final Acceptance.

D. ENGINEER may require additional finish coats if, in the opinion of ENGINEER, the finish is inconsistent in color, texture, or has holidays, areas of unusual porosity or exhibits other imperfections.

E. Only the installer shall repair or replace deteriorated or defective Work.

F. Clean the exterior insulation and finish system Work as recommended by the manufacturer.

3.6 CLEANING AND PROTECTION

A. Remove temporary covering and whatever other provisions were made to minimize spattering of ground, primer and finish coats on other work. Promptly remove ground primer and finish coats from surfaces which are not to be finished as part of

the Work of this Section. Repair surfaces which have been stained, marred or otherwise damaged during the exterior insulation and finish system Work. When exterior insulation and finish system Work is completed, remove unused materials, containers, and equipment and other debris caused by the Work of this Section.

B. Protect exterior insulation and finish system Work from deterioration and damage during remainder of construction period.

+ + END OF SECTION + +

SECTION 07 50 00

SINGLE PLY MEMBRANE ROOFING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as specified and required to furnish and install the single-ply roofing system as shown on the drawings or specified herein.

B. Coordination:
   1. Review requirements and procedures under other Sections and coordinate with Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single installer skilled, trained and with successful experience in the installation of single-ply roofing systems, who is a recognized roofing installer with specific skill and successful experience in the type of roofing specified, and equipped to perform workmanship in accordance with the Contract Documents, manufacturer's written instructions for guaranteed construction and the approved Shop Drawings and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owners, architects or engineers responsible for projects.
      b. Approximate contract cost of the single-ply roofing system.
      c. Amount of area installed.
   2. Submit proof of acceptability of installer by manufacturer to ENGINEER.
   3. The roofing installer shall be an approved roofing applicator who has qualified for appointment and has been trained by the manufacturer. Certified Duro-Last Contractors are listed in Table 1 below:

Table 1: Approved Dura-Last Roofers

Broken Arrow Roofing 117 W. University Ave. Mesa, AZ 85234 Phone: 480-890-0989 Fax: 480-890-2322 Contact: Rob Seals Cell 602-432-3978	Right Way Roofing 1818 Sericin Circle Mesa, AZ 85205 Phone: 480-232-5451 Fax: 480-882-1870 Contact: Johnny Clark Cell 623-707-5325
Jim Brown and Sons Roofing 6623 N. 67th Ave. Glendale, AZ. 85301	Starkweather Roofing 2350 W. Holly Phoenix, AZ 85009

Phone: 623-247-9252 Fax: 623-435-8577 Contact: Ron Brown Cell 602-571-8802	Phone: 602-997-0529 Fax: 602-395-0369 Contact Jeff Starkweather Cell 602-763-4780
Progressive Roofing 25 N. 35th Ave. Phoenix, AZ. 85009 Phone: 602-278-4900 Fax: 602-278-8014 Contact: Mark Bagnolli	

B. Performance Criteria: Provide the following:
   1. Except as otherwise shown on the Drawings, comply with the written specifications and recommendations of the roofing manufacturer. In addition, comply with Factory Mutual Publication 1-28 Technical Advisory Bulletin for Class 1-90 wind up-lift resistance. Select appropriate entries in Table 3 of 1-28 for submission to ENGINEER for approval.
   2. Single-ply roofing system, base and other flashings shall be permanently weather- and watertight, and not deteriorated in excess of manufacturer's published limitations.
   3. Specified manufacturer’s installation and product specifications and details, unless more stringent criteria shown on the Drawings or specified, is acceptable to the single-ply roofing system manufacturer specified.

C. Requirements of Regulatory Agencies:
   1. Comply with applicable insurance rating bureau requirements as required by the Uniform Building Code as supplemented by the City of Phoenix, Building Construction Code, unless more restrictive requirements are specified.
   2. Provide materials and roofing systems which have been tested, listed and labeled by Underwriters Laboratories' Incorporated for Class "A" rating, and bear the UL label on each package or are shipped to the site with a UL Certificate of Compliance.
   3. Provide roofing materials which have been tested, listed and FM labeled for Class "A" maximum flame spread rating.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except otherwise shown or specified.
   1. ASTM D 312, Specification for Asphalt Used in Roofing.
   2. ASTM D 395, Test Method for Rubber Property - Compression Set.
   3. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
   4. ASTM D 471, Test Method for Rubber Property - Effect of Liquid.
   5. ASTM D 542, Test Methods for Index of Refraction of Transparent Organic Plastics.
   6. ASTM D 573, Test Method for Rubber - Deterioration in an Air Oven.
   7. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   8. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

9. ASTM D 1149, Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber.
10. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
11. FM, 1-28, Wind Loads to Roof Systems and Roof Deck Securement.
12. FM, 1-29, Above-Deck Roof Components.
13. FM, 1-28R and 1-29R, Roof Systems.
14. FM, 1-49, Perimeter Flashing.
15. Uniform Building Code as supplemented by the City of Phoenix, Building Construction Code.

E. Source Quality Control:
1. Obtain membrane sheets from only one manufacturer, who publishes complete information on the specified roofing system, and offers to guarantee the completed roofing installation, as required.
2. Take field dimensions prior to preparation of Shop Drawings.

F. Allowable Installation Tolerances:
1. Do not install Work until substrate preparation and tolerances have been approved by ENGINEER, single-ply roofing system manufacturer's Technical Representative and the single-ply roofing system installer and CONTRACTOR have verified to ENGINEER that substrates are within tolerances specified and acceptable to produce approved Work. Work advanced for any reason without such verification shall be stopped, removed and replaced with new material after substrate is approved, at no additional cost to OWNER.

2. Substrate Tolerances:
   a. Out-of-Plane: 1/8-inch maximum in 10 foot-0 inches and 1/16-inch maximum in any 12-inches measured along the plane.
   b. Maximum Offset in Plane Alignment: 1/16-inch.
   c. Variation From Slope: 1/8-inch maximum in 10 foot - 0 inches.

G. Pre-Installation Meeting:
1. Conduct as specified in Section 01 31 19.23, Progress Meetings.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. 12-inch by 12-inch sheet of each item specified and 6-inch long pieces of each required system component to be used in the Work. Comply with the requirements of Section 01 33 23.15, Samples.
2. Each fastener type required marked as to type of material and with their intended purpose in the Work.
3. All components of the single-ply roofing system, flashing and labeled with their intended use in the Work. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Provide outline of roof and roof dimensions, perimeter, penetrations and special details, a section layout, and locations of all heavy-duty walkway protection

paver patterns required by the manufacturer for warranted construction. Submit all details requiring consideration and the performance of the details shall be approved by the single-ply roofing system manufacturer for guaranteed construction as specified. Show the locations of factory dielectric welds, field welds, accessories and materials list.

2. Manufacturer's specifications and product manuals indicating product information correlated to specified requirements, manufacturer's installation instructions, maintenance instructions and other data as may be required by ENGINEER.
3. Copies of the FM Loss Prevention Data publications and appropriate Technical Advisory Bulletins published by Factory Mutual indicating compliance with wind uplift pressure-resistant performance criteria and the requirements for FM Approved 1-90 system construction and perimeter securement conditions.

C. Statement of Application: Upon completion of the Work, submit a statement to ENGINEER signed by CONTRACTOR stating that the Work complies with the requirements of these Specifications and the installation methods comply with the manufacturer's printed instructions and were proper and adequate for the condition of installation and use.

D. Guarantee:
1. CONTRACTOR to execute his own written guarantee direct to OWNER warranting all single-ply roofing system and flashing weather- and watertight and perfect for a period of two years after date of Final Completion. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of the OWNER at CONTRACTOR'S expense.
2. In addition to the above, CONTRACTOR to provide OWNER with manufacturer's standard fifteen years Unlimited Penal Sum Warranty certificate. Manufacturer’s guarantee shall be for the full roofing system repairs and/or replacement covering materials and labor. The warranty shall have no-dollar limit for replacement at then current materials and labor prices, with no exclusions for ponded water, biological growth, and incidental of consequential damages.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver materials to the site in sufficient quantities to ensure uninterrupted progress of the Work.
2. Deliver materials in manufacturer's original, unopened and undamaged containers and rolls with labels intact and legible.
3. Materials requiring fire resistance classification shall be delivered to the job with labels attached and packaged as required by labeling service.

B. Storage and Handling of Materials:
1. Store materials in a dry, well ventilated, weather tight place, and in a manner which will ensure that there is no possibility of significant moisture pick-up.
2. Store in a manner which complies with fire and safety regulations.

3. Store emulsions at temperatures above 40°F.
4. Store materials on clean raised platforms with weather protective covering when stored outdoors.
5. Handle rolled goods so as to prevent damage to edge or ends.
6. Select and operate material handling equipment so as not to damage existing construction or applied roofing.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Proceed with single-ply roofing system and associated Work only when weather conditions will permit unrestricted use of materials and quality control of the Work being installed, complying with the Specification requirements and with the recommendations of the roofing materials manufacturers.
   2. Proceed only when CONTRACTOR and his installer are willing to guarantee the Work as required and without additional reservations and restrictions.
   3. Record decisions, conditions and agreements to proceed with the Work when weather conditions might be unfavorable. State the reasons for proceeding, with the names of the persons involved along with the changes, if any, or revisions, requirements or terms of the Contract.

B. Protection:
   1. Provide continuous protection of materials against damage primarily by storing materials under cover and above ground and away from other construction traffic.
   2. Provide continuous protection of materials against wetting and moisture absorption.
   3. Protect materials against damage by construction traffic.
   4. Protect the deck to ensure that it is not overloaded. Concentrated burdens should be avoided or distributed.

C. Scheduling:
   1. Proceed with and complete the Work only when materials, equipment and skilled tradesmen required for the installation of other single-ply roofing system components are at the site and are ready to follow with the Work.
   2. Install all single-ply roofing system and associated Work in a manner that will ensure a complete roofing system at the end of each day's Work. Do not advance the installation of any one material beyond that which is necessary for proper sequencing of the single-ply roofing system Work.
   3. Notify the ENGINEER and the roofing manufacturer’s representatives before starting work, allowing sufficient time to arrange for inspection of the work and conditions.

PART 2 - PRODUCTS

2.1 MATERIALS AND MANUFACTURERS

A. Membrane Roofing System: Provide the following:

1. Thermoplastic coated CPA membrane consisting of a weft polyester scrim (18 x 14, 100 denier) laminated on both sides with a plasticized blend of vinyl and acrylic polymers. Include 3-1/4-inch securing tabs dielectrically welded 60-inches on center to receive fasteners and distribution plates. Comply with the following:
   a. Co-polymer alloy (CPA) white membrane 60 mils thick by Duro-Last Roofing, Inc. Provide prefabricated factory dielectrically welded sheets up to 200 square feet or as determined to fit job conditions.
   b. Roofing system must meet UL Class A requirements with all packaging bearing the UL label.
   c. Factory shall prefabricate all membrane components, including pipe and curb flashings from the same fabric reinforced deck membrane material.
   d. Minimum performance and physical specification requirements for membrane shall be per the following table:

MINIMUM PERFORMANCE AND PHYSICAL SPECIFICATION REQUIREMENTS FOR MEMBRANE

Physical Property	Test Method	Specification Requirements
Thickness min.	ASTM D-751	.0560 inch thick (50 mils)
Tear Strength, Toung Method 8" x 8" sample	ASTM D-751	140 x 110 lbf
Breaking Strength	ASTM D-751	435 x 350 lbf
EMMAQUA Exposure	ASTM E938, Desert Sun	> 6.9 million langleys
Elongation	ASTM D-751	35%
Dimensional Stability	ASTM D-1204	<0.1%
Low Temperature Flexibility	ASTM D-2136, 1/8" mandrel	No cracks, -40 degrees F
Dynamic Impact (Puncturing)	Fed. Std. 1013, Method B	350 lbs
Water Vapor Transmission	ASTM E96 WVT, Procedure B, Method A	> .25 US Perms, 0.086 g/hr/sqm
Accelerated Weathering	Carbon Arc, 6000 Hours	No cracks, crazing, or blistering
Accelerated Weathering UVB-313 Lamp @ 80 degrees C	ASTM G-5388, 2000 Hrs.	No cracks, crazing, or blistering
Factory Mutual Research	ASTM E-108	Class 1 I-60 & I-90
Underwriter's Laboratory	UL-790	Class A
Scrim: Weft inserted Polyester		18 x 14, 1000 denier

2. Slip Sheet: Provide the following:
   a. 3 mil polyethylene or polypropylene materials, 15 feet wide
3. Product and Manufacturer: Provide the following:
   a. Duro-Last thermoplastic coated CPA membrane, classified by UL as a Class A Sheathing Material.

B. Two-Way Breather Vents:
   1. Provide two-way vents with factory-attached skirt, installed at a density of one per 1000 square feet of roof deck area and per Duro-Last Roofing, Inc.'s specifications.2. Coordinate adhesives and sealants for full system responsibility.

C. Miscellaneous Materials: Provide the following:
   1. Termination Sealant: Compatible with bonding materials and conforming to Federal Specifications TT-598 and TT-S-00230C.
   2. Distribution Plates: High strength polyblend for slip sheet and membrane attachment. Two inch Poly-Plates.
   3. Water Cut-Off Mastic: Compatible with materials where it is used. Pitch Pocket Sealant: A single component, self-leveling silicone sealant.
   4. Fasteners: Duro-Guard coating #14, must pass 30 cycles in the Kesternick Cabinet, DIN#50018-2 Liter.
   5. Terminations/Edge Details: Manufactured from rigid exterior vinyl with slotted holes for securement. All other terminations/edge details must be approved and warranted by Duro-Last.
   6. Walkway Pads: Duro-Last walkway pads made from the membrane material. Non-skid, maintenance free pads in a contrasting color to the roof membrane.
   7. Scuppers: Provide factory formed single skirt metal scuppers to fit the existing scupper openings.
   8. Provide factory prefabricated or manufactured accessories by or under the direction of Duro-Last. All others as approved by Duro-Last.
   9. Other miscellaneous and accessory materials required for guaranteed construction.

2.2 FABRICATION

A. Use manufacturer's standard sheet seaming system for "plastic welding" or lapped joints to create seams of strength equal to sheet strength.

B. Include edge sealer to cover exposed sheet edges.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which the single-ply roofing system and base flashing Work is to be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Verify adequacy of slope-to-drain, compressive strength, moisture content and other composite roof insulation features important to the successful installation of the single-ply roofing system and flashing before start of Work.

3.2 PREPARATION

A. Clean the substrate of dust, debris, substances and interferences detrimental to the Work. Where necessary to remove sharp projections, composite insulation surfaces shall be ground.

B. Fill voids, joints and rough areas in the substrate with elastomeric sealant or other underlayment compound recommended by the single-ply roofing system manufacturer.

C. Test the substrate for excessive moisture as recommended by the single-ply roofing system manufacturer.

3.3 INSTALLATION

A. General:
   1. Provide qualified, trained workers to property install the manufacturer's system. Provide a certified, trained, experienced, qualified superintendent who is familiar with requirements of the project and who is on the job during all roofing work.
   2. Follow all applicable installation instructions and recommendations contained in the single-ply roofing system manufacturer's written installation and product manuals and the information contained on approved Shop Drawings. Where CONTRACTOR requests to deviate from written installation and product manuals and approved Shop Drawings, all such deviations shall be submitted to ENGINEER for approval along with single-ply roofing system manufacturer's written agreement and a statement of acceptability for compliance with guaranteed construction.
   3. Begin installation only in the presence of the single-ply roofing system manufacturer's technical representative.
   4. Proceed with roofing work only when weather conditions permit and when within manufacturer's recommendations. Install roofing material as specified by manufacturer.
   5. Cut sheets to the maximum size possible, in order to minimize seams and to accommodate contours of the deck. Do not seam within four feet of roof drains.
   6. Clean all splices and lap areas using manufacturer's recommended splice cleaner.
   7. Lap sheets and bond joints using the seaming system recommended by the manufacturer.
   8. Cover top edges of each sheet at seams with uniform fillet of special sealant.

B. Substrate: Inspect all surfaces to receive roofing for any condition that will adversely affect execution, performance, or quality of work and correct all such conditions. Check all roof surfaces, sloped surfaces to drains and outlets, and approve same prior to the start of the roofing work. Schedule the roofing work in areas and sections in such a manner as to keep the new and existing materials, and the building dry and watertight. Correct any damage to the facility or contents as a result of improper scheduling of roofing work.

C. Roofing Surfaces: Avoid storing, wheeling, or trucking directly on roof insulation or membrane. Provide smooth, clean plywood or plank walkways and platforms as necessary.

D. Slip Sheet: Use the Poly-Plate fasteners to secure the slip sheet, spaced a maximum of 15 feet on center at all roof deck areas.

E. Layout: Select the proper factory marked rolled sheet of roofing membrane for an outside corner or high point. Orient the roofing membrane so that the 3 inch wide fastening tabs are perpendicular to the walls and, where possible, the ribs or corrugations of the steel deck. When laying out each tab, pull the membrane tight.

F. Roofing Sections: Unfold first sheet along edge of roof or parapet wall. Position and fasten first tab with plates and screws according to membrane manufacturer specifications. Unfold roofing sheet to the second 31/4" wide fastening tab. Pull tab tight and secure to deck, maintaining proper plate and screw frequency, squarely placed. Continue unfolding and fastening membrane until entire sheet is in place. Install the adjacent membrane sheets using the fastening procedure described. Proceed until all sheets are in place, forming a monolithic roof cover. Make sure all edges of each sheet are fastened with the same fastener spacing as tabs or are welded to another sheet that is fastened in this manner.

G. Fasteners: To attach the Duro-Last membrane at all locations, except where adhesive is called for, use 2-inch Poly-Plates and Duro-Last HD Screws. Using a 60 inch lap spacing, apply fasteners 18-inches on centers with the screws penetrating the metal deck a minimum of one inch (from the top surface of the deck).

H. Attachment: Space securement tabs a maximum of 60 inches on center and the first tab on the edge of the sheet parallel to the roof edge at a maximum 36 inches. Attach deck membrane with approved fasteners, 18 inches on center along bottom of all parapet walls, elevation changes and perimeter edges. Fasten deck membrane around cut-outs with approved fasteners 12 inches on center or a minimum of 1 per round penetration having a diameter of not more than 6 inches.

I. Field Welding: Make field heat welds with clean welding surfaces, free of moisture and foreign materials. All field heat seams of the roofing materials 1-1/2 inch wide minimum and made with a hot air welder. Position the hot air welder so the outside edge and both pieces of material will receive an equal amount of heat, all of which will be closely followed by a 1-5/8 inch wide roller specially designed for this purpose. Make a hands and knees inspection of all field welds with a probe.

J. Perimeter: Mechanically fasten the membrane at all roof perimeters, parapets, curbs, walls, penetrations, in strict accordance with Duro-Last specifications and details.

K. Cut-Outs: Make cut-outs in membrane for penetrations through the roof. Some situations might require the membrane be split to the section edge for fitting around penetrations. Fasten around cut-outs with approved fasteners, 12 inches on center or a minimum of one per side. The skirts on factory prefabricated accessories when welded to deck will cover these.

L. Stacks: After membrane has been attached, select proper size of pre-manufactured round stack for roof vents and pipes. Drop stack flashing over the pipe, lay flat to the roof, and heat weld the skirt to the membrane. Tighten stainless steel band or clamp around top of stack flashing to prevent water penetration. Using factory approved sealant, seal the top of the stack flashing at the steel band.

M. Custom Curbs/Pitch Pockets: After securing cut-out as stated, heat weld the bottom of the skirt to the deck membrane. If the square or rectangle penetration has a removable top remove the unit and fold the custom curb flashing over the top, secure, then replace unit. If top is not removable, secure the top of the custom curb flashing with termination bar and seal with factory approved sealant. Use this same procedure on pitch pockets.

N. Breather Vent: Install a two-way breather vent for every 1,000 square feet of deck area. Use factory prefabricated vents with a skirt made from roofing membrane. Heat weld skirt to the deck membrane over a 7 inch hole through the membrane. Careful placement of the breather vents must be observed. DO NOT locate in valleys, next to roof penetrations, roof drains. etc. Equally space the vents throughout the roof area. Do not fasten the vent or the skirt to the roof deck. This two-way breather vent is designed to vent the roofing system only and not the building where it is installed.

O. Parapet Walls: Fasten bottom tab of prefabricated parapet wall flashing 12 inches on center with approved fasteners to secure both bottom of parapet and edge of deck membrane. Extend base skirt approximately 6 inches onto the roof to allow for a 1-1/2 inch wide weld and covering of the fasteners and plates. Heat weld skirt to membrane. On all termination bar applications, start fastening at one end and proceed to the other and eliminate buckling of the termination bar. Seal behind the parapet wall material and on top of termination bar with factory approved sealant.

P. Roof Drains: Secure cut-out made in deck membrane with four (4) equally spaced fasteners and distribution plates. Provide a prefabricated drain boot. Apply factory approved sealant all around drain approximately 12 inches under deck membrane and install the expanding snap rings.

Q. Scuppers: Install the fabricated scuppers in accordance with Duro-Last details, mechanically attached and sealed into the existing scupper openings.

R. Walkway Pads: Provide walkway pads at 2 sides of each roof hatch and around all accessible mechanical equipment. Install in strict compliance with manufacturer's recommends. Secure against displacement for the life of the installation.

S. Roof Hatch Flashing: Delete the existing wedge material around the exterior top of the roof hatches. After replacing the adhered base flashing provide continuous wood wedges to support the top of the Duro-Last membrane. Secure the wedges in place with rust proof screws through the exterior turndown and into the wood.

3.4 PROTECTION

A. Protect single-ply roofing system from damage during the construction period so that it will be undamaged in any way at the time of Final Completion.

B. Protect other Work, and surfaces of membrane, from spillage of single-ply roofing system sealing and bonding materials, and prevent materials from entering and clogging drains and conductors.

C. Replace Work which is soiled or otherwise damaged by the performance of the single-ply roofing system and associated Work and from improper installation techniques.

D. Remove broken, cracked and chipped heavy-duty walkway pavers and replace with undamaged material.

3.5 INSPECTION AND ACCEPTANCE

A. Inspection will include Duro-Last's own Quality Assurance Specialist who, at no charge to the OWNER, will inspect the completed roofing system and issue a written review with a listing of any repairs required.

B. At the end of the construction period, or at a time when the remaining construction Work will in no way affect or endanger the single-ply roofing system and associated Work, a Technical Representative of the single-ply roofing system manufacturer shall make a final inspection of the Work and prepare a written report to OWNER and ENGINEER of deterioration, damage or deficiencies found in the Work.

C. Inspections shall be by Duro-Last Quality Assurance Technician, ENGINEER, CONTRACTOR and Installer. Submit all required drawings, details, and completed questionnaires to Duro-Last to obtain the warranty. After the authorized technician has inspected the roof for determining acceptability for warranty issuance, any reported deficiencies shall be corrected by the Installer and ready for re-inspection within five working days.

D. Only the Installer shall repair or replace deteriorated or defective Work.

E. Provide certification, signed by the manufacturer and CONTRACTOR, that the completed Work is in accordance with the Specifications, and without damage or deterioration (except for normal weathering) at time of Final Completion.

F. Upon completion of work, repair or replace as required, all building materials damaged as a result of the roofing operations. Match existing materials as close as possible and to OWNERS'S approval.

G. Future repairs or additions to the roofing system must be made using the heat welding process. Adhesive bonded or butyl tape repairs are not allowed for the life of the roofing.

H. Upon completion of the membrane installation remove all foreign matter, rubbish and scrap material from the roof. Clean and repair any building and surrounding surfaces soiled and damaged by contract operations to the OWNER'S satisfaction.

+ + END OF SECTION + +

SECTION 07 62 00

FLASHING AND TRIM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install flashing and trim. The Work also includes:
      a. Providing openings in flashing and trim to accommodate the Work under this and other Sections and building into the flashing and trim all items such as sleeves, anchor bolts, inserts and all other items to be embedded in flashing and trim for which placement is not specifically provided under other Sections.
   2. Extent of the flashing and trim is shown on the Drawings.
   3. Types of products required include the following:
      a. Stainless steel sheet flashing.
      b. Lead sheet flashing.
      c. Shop-formed, snap-lock metal coping flashing and shop-formed cap flashing requiring no exposed fasteners or splice-plates.
      d. Extruded gravel stops and fascia extensions.
      e. Custom shop-fabricated metal coping and gravel stop corner and transition flashings.
      f. Surface-mounted reglets and counterflashing.
      g. Built-in-place reglets and counterflashing.
      h. Cast-in-place reglets and counterflashing.
      i. Miscellaneous flashing not supplied under other Sections.
      j. Complete selection of custom and premium custom-blended full-strength, polyvinylidene fluoride finishes and colors with extended life topcoat.
      k. Protective strippable film on all surfaces of snap-lock metal coping, extruded aluminum gravel stops, fascia extensions and metal coping corner and transition flashings.
      l. Miscellaneous accessories, fasteners, cleats and incidental flashing and trim system components necessary for a complete installation.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the flashing and trim.
   2. Work advanced without flashing and trim items that are specified to be cast-in-place or built-in-place as the Work advances, shall be stopped, demolished and rebuilt incorporating specified flashing and trim, at no additional cost to OWNER.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage a single installer who is a recognized flashing and trim installer, skilled and experienced in the type of flashing and trim Work required, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work. Submit name and qualifications to ENGINEER along with at least three successfully completed Projects including names and telephone numbers of owners, architects and engineers, responsible for the Project and the approximate contract price for flashing and trim.
2. The installer of the flashing and trim Work shall be franchised or otherwise accepted, in writing, by the built-up bituminous roofing materials manufacturer for installation of fully guaranteed built-up bituminous roofing Work in accordance with the Specifications.

B. Source Quality Control:
   1. Except as otherwise shown on the Drawings, comply with recommendations of the built-up bituminous roofing manufacturer concerning the installation of flashing and trim that affects the built-up bituminous roofing bond or guarantee.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 480, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   2. ASTM A 666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar.
   3. ASTM B 29, Specification for Refined Lead.
   4. ASTM B 32, Specification for Solder Metal.
   5. ASTM B 101, Specification for Lead-Coated Copper Sheet and Strip for Building Construction.
   6. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
   7. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   8. ASTM B 370, Specification for Copper Sheet and Strip for Building Construction.
   9. ASTM B 749, Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
   10. ASTM D 395, Test Methods for Rubber Property-Compression Set.
   11. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
   12. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
   13. ASTM D 523, Test Method for Specular Gloss.
   14. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   15. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   16. ASTM D 968, Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive.
   17. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
   18. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
   19. ASTM D 2244, Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

20. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
21. ASTM D 3363, Test Method for Film Hardness by Pencil Test.
22. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
23. The Aluminum Association, AA, ASD-1 - Aluminum Standards and Data.
24. The Aluminum Association, AA, SAA-46 - Standards for Anodized Architectural Aluminum.
25. The Aluminum Association, AA, DSA-45 - Designation System for Aluminum Finishes.
26. Factory Mutual Engineering Corporation, FM Loss Prevention Data for Roofing Contractors, 1-49 - Perimeter Flashing.
27. National Roofing Contractors Association, NRCA, Low-Slope Membrane Roofing Construction Details Manual.
28. Sheet Metal and Air Conditioning Contractors National Association, Incorporated, SMACNA, Architectural Sheet Metal Manual.
29. Steel Structures Painting Council, SSPC - Paint 12, Specification for Cold-Applied Solvent-Type Bituminous Mastic Coating.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. 12-inch square samples of specified flashing and trim metals.
   2. Each item of gravel stop and coping system, demonstrating assembly of system joint components and fasteners, securely mounted to substrate simulating actual installation in the Work.
   3. Polyvinylidene fluoride manufacturer's color samples for final selection by ENGINEER. After initial selection of colors by ENGINEER from manufacturer's color charts, submit ENGINEER'S preliminary color choices on actual samples of metal substrate for final color selections by ENGINEER.
   4. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, installation instructions and general recommendations for flashing and trim required. Include manufacturer's data substantiating that the materials comply with the requirements. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
   2. Drawings showing the manner of forming, jointing and securing flashings and trim. Show fully dimensioned joint details and waterproof connections to adjoining Work and details at obstructions and penetrations.
   3. Drawings showing the coordination of the Work of this Section with Section 04 20 00, Unit Masonry Construction, and Section 07 50 00, Single Ply Membrane Roofing. Provide detailed Shop Drawings showing large scale details of sections and profiles of all flashing and trim to be used in the Work, with all items, including fastener locations, cleats and other miscellaneous accessories necessary to complete the Work, fully dimensioned, properly located, quantified and presented such that sequence of installation is acceptable to each roofing system and adjacent construction material installer.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver flashing and trim materials in manufacturer's original, unopened, and undamaged containers and rolls, with labels intact and legible, indicating compliance with approved Shop Drawings.
   2. Items delivered in broken, damaged, rusted, or unlabeled condition shall immediately be removed from site and not offered again for approval by ENGINEER.
   3. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage and Handling of Materials:
   1. Store materials in an area under cover and protected from construction traffic.
   2. Store materials in same package in which they were shipped, off the ground and on platforms protected from dirt and other contamination.
   3. Store in a manner which does not permit water to remain on flashing and trim materials and system components.
   4. Protect flashing and trim from dents, scratches, warps and bends.
   5. Remove strippable protective film, immediately proceeding installation of each system component.
   6. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

1.5 JOB CONDITIONS

A. Scheduling:
   1. Do not proceed with flashing and trim Work until curb and substrate construction, cant strips, blocking, reglets and other construction to receive the Work is completed.
   2. Deliver materials to the site in sufficient quantities to ensure uninterrupted progress of the Work.
   3. Schedule the installation of flashing and trim to coincide with the installation of built-up bituminous roofing, waterproofing, drains, piping, blocking, nailers, reglets, framing at openings, curbs, parapets and other adjoining and substrate Work.
   4. Proceed with and complete the Work only when materials, equipment and knowledgeable tradesmen, required for the installation of flashing and trim, are at the site and are ready to follow, and integrate flashing and trim Work with roofing Work, in order to maintain watertight conditions.

1.6 GUARANTEE

A. Provide coping and cap flashing manufacturer's fifteen year warranty against blow-off, leak, or premature membrane failure in winds of up to 110 miles per hour.

B. Provide manufacturer's twenty-year warranty on the specified coil coated polyvinylidene fluoride based coating.

C. Guarantee that the polyvinylidene fluoride based coating meets all criteria specified and will not spall, check, craze, peel or otherwise lose adhesion for a period of

twenty years from the date of installation, to the extent that such shall create unsightly conditions or otherwise impair the intended architectural qualities of the building.

D. In the event that the coil coated polyvinylidene fluoride based coating fails to meet the specified standards the manufacturer shall, at his own expense, replace or field paint, at the discretion of OWNER, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.

E. The warranty specified shall not deprive OWNER of other rights OWNER may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under requirements of the Contract Documents.

F. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the manufacturer.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Flashing and trim shall be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.
   2. Snap-lock coping shall be detailed, fabricated and installed to provide a minimum of FM 1-90 wind up-lift resistance and require no exposed fasteners of any kind.
   3. Comply with fabrication details recommended by FM, SMACNA, NRCA and the requirements of the flashing and trim manufacturer, and as shown on approved Shop Drawings.

2.2 MATERIALS

A. Metal Flashing and Trim:
   1. Stainless Steel Flashing and Trim: Provide 26 gage sheet stainless steel, Type 316, complying with ASTM A 666, with No. 2D dead soft, fully annealed finish, unless required to be harder temper for proper forming and performance for application indicated.
   2. Lead Flashing and Trim: Provide sheet formed from common desilverized pig lead complying with ASTM B 29 and ASTM B 749; weighing 6.0 pounds per square foot.
   3. Lead-Coated Copper Flashings and Trim: Provide cold-rolled sheet copper complying with ASTM B 370 of proper temper for application shown on the Drawings and required forming. Provide lead coating complying with ASTM B 101, Type 1, Class A, not less than 0.06 pounds per square foot of lead coating on one side; weighing 1.06 pounds per square foot.
   4. Aluminum Flashing and Trim: Provide aluminum complying with ASTM B 209, alloy 3003, temper H14. Provide sheet aluminum 0.032-inches thick with AA-C22A41 finish.

B. Formed Metal Coping, Caps and Trim: Provide smooth sheet of 16-gage, 5005-H134 aluminum alloy, complying with the following:
   1. Provide coping and cap flashings, sized as shown on the Drawings, that provides for independent mounting and full expansion and contraction over prefabricated 6-inch wide aluminum retainers, compression clips mounted 12 feet - 0 inches on centers, and 2-inch wide aluminum retainer plates with single compression pad mounted between dual compression clips.
   2. Provide system that incorporates a gutter bar with dual compression gaskets at each joint to drain water.
   3. System shall not incorporate exposed sealants.
   4. Provide internal face line-up splices at all joints.
   5. All coping and cap flashings shall have all corners mitered and continuously heliarc welded watertight prior to shop-painting. Exposed mechanical fasteners, blind rivets and similar methods are not approved for the Work. Reinforce metal at welds as may be required to provide welded seams.
   6. Concealed fasteners, splice plates and neoprene compression pads shall be as recommended by the manufacturer.
   7. Product and Manufacturer: Provide one of the following:
      a. Gutter Splice System TITE-LOC Coping by Peterson Aluminum Corporation.
      b. Or equal.

C. Extruded Aluminum Gravel Stops and Fascia Sections: Provide extrusions of 6063-T-52 aluminum alloy, complying with the following:
   1. Provide optional extruded fascia and optional aluminum soffit trim section finished to match gravel stops.
   2. Provide gravel stops that utilize concealed joint covers for a flat, clean, unbroken line appearance.
   3. Provide hold-down clips 36-inches on center.
   4. Concealed Joint Plates: Same material and finish as gravel stop flashing 9 feet - 11 inches on center.
   5. Provide special flashings as required, all pre-fabricated at the shop; of formed sheet 5005-H134, aluminum alloy, 16-gage. Finish to match extruded aluminum gravel stops and fascia sections.
   6. Product and Manufacturer: Provide one of the following:
      a. 79591 Gravel Stop Section, 79589 Fascia Units and 79590 Soffit Trim by Architectural Products Company.
      b. Or equal.

D. Elastic Sheet Flashing:
   1. Polychloroprene synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
      a. Hardness, ASTM D 2240: 50 to 70 Shore A.
      b. Tensile Strength, ASTM D 412: 1500 psi.
      c. Tear Strength, ASTM D 624: 120 pounds per linear inch.
      d. Elongation, ASTM D 412: 300 percent.
      e. Brittleness Temperature, ASTM D 746: -30°F.
   2. Butyl synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
      a. Hardness, ASTM D 2240: 50 to 70, Shore A.

b. Tensile Strength, ASTM D 412: 1200 psi.
c. Tear Strength, ASTM D 624: 200 pounds per linear inch.
d. Elongation, ASTM D 412: 300 percent.
e. Brittleness Temperature, ASTM D 746: -30°F.

3. Ethylene-propylene-diene monomer synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
   a. Hardness, ASTM D 2240: 50 to 70, Shore A.
   b. Tensile Strength, ASTM D 412: 1400 psi.
   c. Tear Strength, ASTM D 624: 125 pounds per linear inch.
   d. Elongation, ASTM D 412: 300 percent.
   e. Brittleness Temperature, ASTM D 746: -75°F.

E. Flashing Reglets:
   1. General:
      a. Provide snap-lock type reglets of Type 304 stainless steel, 0.020-inches minimum thickness.
      b. Provide reglets that engage counterflashing by use of a snap-lock or spring-lock profile. System shall employ only mechanical interlocking features for securing counterflashing in reglet, without the need for clips or screws.
      c. Provide manufacturer's standard Type 304 stainless steel spring-lock profile flashing, 5-1/8-inches high, designed to incorporate a positive air break and to engage spring-lock reglet flange.
      d. Provide reglets with 1-inch end laps and spring-lock flashing with 3-inch end laps.
   2. Cast-In-Place Reglets: Provide cast-in-place reglets for concrete with manufacturer's standard foam backer rod to prevent cement from entering reglet.
      a. Provide reglet with a vertical snap-lock engagement slot, 1-inch high by 1/2-inch deep with connector alignment clips and special staples for securing to formwork.
      b. Product and Manufacturer: Provide one of the following:
         1) Type CO Concrete Reglet by Fry Reglet Corporation.
         2) Or equal.
   3. Built-In-Place Masonry Reglets: Provide built-in-place reglets for masonry installation with top flange 4-inches wide to penetrate the first wythe of brick.
      a. Provide reglets without exposed fasteners of any kind. Provide engagement flange 1-1/8-inch high by 1/2-inch wide with snap-lock profile designed to pressure-lock counterflashing in place.
      b. Product and Manufacturer: Provide one of the following:
         1) Type MA-4 Masonry Reglet by Fry Reglet Corporation.
         2) Or equal.
   4. Surface-Mounted Reglets: Provide reglets for surface mounting, with slots for expansion, and a complete line of manufacturer's standard accessories including drive pins, and 7/8-inch diameter stainless steel washers with neoprene facing.
      a. Provide engagement flange 2-1/2-inch high by 1/2-inch wide with snap-lock profile shaped to receive sealant at top lip edge and at mid-flange recess.
      b. Product and Manufacturer: Provide one of the following:
         1) Type SM Surface Mounted Reglet by Fry Reglet Corporation.

2) Or equal.

5. Surface-Mounted Stucco Reglets: Provide reglets for surface mounting that incorporates a V-edged mounting flange which projects 7/8-inches from the face of the mounting flange and permits stucco to be applied directly over the reglet.
   a. Provide engagement flange 2-1/2-inch high by 1/2-inch wide with snap-lock profile, shaped to act as an edging bead for stucco.
   b. Product and Manufacturer: Provide one of the following:
      1) Type STX Stucco Reglet by Fry Reglet Corporation.
      2) Or equal.

F. Miscellaneous Materials:
   1. Burning Rod for Lead: Same composition as lead sheet.
   2. Solder for Copper: ASTM B 32, 50 percent tin and 50 percent lead, used with rosin flux.
   3. Solder for Stainless Steel: ASTM B 32, 60 percent tin and 40 percent lead alloy grade 60A, used with an acid flux of the type recommended by the stainless steel manufacturer. Use a non-corrosive rosin flux over tinned surfaces.
   4. Stainless Welding Rods: Type recommended by stainless steel sheet manufacturer for the type of metal sheets furnished.
   5. Nails, Screws and Rivets: Same material as flashing sheet, or as recommended by manufacturer of flashing sheet.
   6. Cleats: Same metal and gage as sheet being anchored, 2-inches wide, punched for two anchors.
   7. Bituminous Coating: SSPC-Paint 12, cold-applied solvent-type bituminous mastic coating for application in dry film thickness of 15 mils per coat.
   8. Sealants: Refer to Section 07 92 00, Calking and Sealants.
   9. Roofing Cement: Provide a medium to heavy trowel-grade, cut-back asphalt mastic roof cement reinforced with non-asbestos fibers, and containing petroleum solvents and special mineral stabilizers, complying with ASTM D 4586, Type II.
   10. Base Flashing Felts: Asphalt-coated, polyester/glass scrim reinforced flashing sheet or as recommended by the manufacturer of the built-up bituminous roofing.

2.3 FABRICATION

A. Fabricated Metal Flashing: Shop-fabricate metal flashing and trim to comply with profiles and sizes shown on the Drawings, and to comply with manufacturer's recommended details. Except as otherwise shown on the Drawings or specified, provide soldered flat-lock seams, and fold back metal to form a hem on the concealed side of exposed edges. Comply with metal producers' recommendations for tinning, soldering and cleaning flux from metal.

B. Fabricated Elastic Flashings: Shop-fabricate elastic flashing to comply with profiles and sizes shown on the Drawings and to comply with elastomeric material manufacturer recommendations.

C. Provide completely shop-fabricated corners and transition flashing and trim for all coping, cap flashing and gravel stops; heliarc welded to ensure watertight joints.

Grind all welds smooth so as to be indistinguishable from surrounding surfaces. Finish with specified paint system after fabrication.

D. Where fabricator does not recommend grinding welds smooth, comply with SMACNA formed metal details requiring double-lock seamed construction.

2.4 ALUMINUM COPINGS, GRAVEL STOPS AND CAP FLASHING FINISHES

A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded or factory-fabricated material. Provide the following four coat finish system complying with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold water rinse. Seal with a chromic acid rinse and dry, except where manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in it's coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 to 0.4 mils. Follow with a barrier coat, 1.0 mils thick.
   4. Apply color coat containing mica pearlescent or metallic flakes over the barrier coat by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440°F for a dry film thickness of 0.7 mils for coil coating and 1.2 mils for spray coating so that the total dry film is approximately 1.0 mil thick for coil material and 1.5 mils thick for extruded material.
   5. Apply clear fluoropolymer top coat to provide a dry film thickness of 0.4 to 0.8 mils. The entire four coat system shall have a dry film thickness of 2.6 mils minimum.
   6. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to ENGINEER:
      a. Weathering, ASTM D 4214: Chalking, not more than No. 8, after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D 2244: No greater than 5 NBS units after removal of external deposits and after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D 2247; no blisters after 3000 hours.
      d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16-inch creep from areas scribed to bare metal after 3000 hours.
      e. Dry Adhesion: No pick-off when tape tested over 1/16-inch cross hatch.
      f. Wet Adhesion: No pick-off when tape tested over 1/16-inch cross hatch; extruded material only.
      g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after one hour immersion in distilled boiling water.
      h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10°F after 500 hours.
      i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67 minimum.
      j. Gloss, ASTM D 523: 30±5 reflectivity at 60°F.

k. Pencil Hardness, ASTM D 3363: HB-H minimum.
l. Dry Film Thickness, ASTM D 3363: Primer, 0.2 to 0.4 mils; barrier coat, 1.0 mils; color coating, 0.7 to 1.5 mils; clear topcoat, 0.4 to 0.8 mils.
m. Solvent Resistance: 100 Double MEK rubs minimum.
n. Flexibility, ASTM D 522: No cracking prior to metal fracture.
o. Acid Resistance, ASTM D 1308: 16 hour spot test with five percent hydrochloric acid - no effect.
p. Alkali Resistance, ASTM D 1308: 16 hour spot test with five percent sodium hydroxide - no effect.

B. Colors: Provide the following:
1. Full selection of manufacturer's standard, custom and premium colors for final selection by ENGINEER.
2. ENGINEER will select custom special extended life premium colors for flashing and trim at time of Shop Drawing and sample submission review.

C. Product and Manufacturer: Provide one of the following:
1. Duranar Metallic XL Specialty Color 4-Coat System by PPG Industries Coatings and Resins Division, Incorporated.
2. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which the flashing and trim Work is to be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with flashing and trim Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Before installing flashing and trim, verify shapes, and dimensions to be covered.

B. Prepare substrates as recommended by the sheet metal manufacturer.

3.3 INSTALLATION

A. General:
1. Separate dissimilar metals from each other by painting each metal surface in the area of contact with a heavy application of bituminous coating, or by other permanent separation as recommended by the manufacturers of the dissimilar metals. Comply with the following:
a. Separate stainless steel from dissimilar metals, including regular steel and iron, and from cementitious materials by a course of roofing felt, wherever possible. Where felt application is not possible, coat the stainless steel or the other material with a 15-mil bituminous coating. Where felt is applied under sheets which will be soldered or welded, cover felt with a course of building paper before installing stainless steel. Comply with

manufacturer's recommendations for other forms of protection of the stainless steel against corrosion.

b. In addition to bituminous coatings, apply a heavy tinning of solder at locations where lead-coated copper contacts dissimilar metals.

2. Provide thermal expansion for running trim, flashing, valleys, and other items exposed for more than 15 feet-0 inches continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams as shown on the Drawings or, if not shown, at the following maximum spacings for each general flashing use:
   a. Valleys: Midway between drains (at high points in slopes), but in no case more than 30 feet-0 inches apart, except as otherwise shown on the Drawings.
   b. Flashing and Trim: At 10 feet-0 inch intervals, and 2 feet-0 inch each side of corners and intersections.
3. Fabricate and install Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat flat-locked seams with minimum exposure of solder, welds and sealant. Except as otherwise shown on the Drawings, fold back the sheet metal to form a hem on the concealed side of exposed edges. All exposed edges of all sheet metal flashing shall be hemmed not less than 1/2-inch wide.
4. Conceal fasteners and expansion provisions wherever possible in exposed Work, and locate so as to minimize the possibility of leakage. Cover and seal Work as required for a watertight installation.
   a. Provide cleat-type anchorages for metal flashings and trim wherever practical, arranged to relieve stresses from building movement, and thermal expansion and contraction.
5. On vertical surfaces lap two-piece flashings a minimum of 4-inches.
6. On sloping surfaces, for slopes of not less than 6-inches in 12-inches, lap unsealed flashings a minimum of 6-inches. For slopes less than 6-inches in 12-inches use soldered flat locked seams.
7. For embedment of metal flashing flanges in built-up bituminous roofing or composition flashing or stripping, extend flanges for a minimum of 4-inches embedment.

B. Installation of Stainless Steel Flashing and Trim:
   1. Tin the edges of plain stainless steel to be soldered, for a width of 1-1/2-inches, using solder for stainless steel and acid flux. Remove every trace of acid flux residue from the metal promptly after tinning or soldering.
   2. Where welded joints are shown on the Drawings, provide upturned, 1/2-inch wide hooked flanges, and weld between adjoining sheets; lay seam flat.

C. Installation of Lead Flashing and Trim:
   1. Where prefabricated units of lead flashing are to be set in felts the under side may be coated with roofing cement.
   2. Cut and shape lead sheets in place with minimum of 1-inch lapped joints, and form bends and folds to provide corners and intersections as shown. Shave or wire-brush joint areas immediately before sealing joint.
   3. Burn joints in lead sheets to provide true welded construction, exercising care to avoid reduction of sheet thickness.

D. Installation of Aluminum Flashing and Trim:
   1. Bed base members and flashings of aluminum in roofing cement. Comply with manufacturer's instructions for installation and anchorage of units. Provide gasket-type washers under exposed screw and bolt heads. Shim and seal under units as required to provide continuous, level, plumb and true lines.

E. Lead-Coated Copper Flashing and Trim:
   1. Wire brush the edges of the lead-coating copper sheet for a width of 1-1/2-inches.
   2. For lead-coated copper flashing and trim provide flat-locked seams, with minimum of 1/2-inch wide hooked flanges.

F. Installation of Metal Copings and Extruded Gravel Stops and Fascia Sections:
   1. Install metal copings using concealed fasteners and plates in compliance with manufacturer's written recommendations as shown on approved Shop Drawings.
   2. Coping and cap flashings shall be installed with 3/8-inch wide butt joints 12 feet-0 inches on center, unless otherwise shown on the Drawings.
   3. Use all items supplied by the manufacturer for a complete, watertight and blow-off resistant installation.
   4. Set all flashings straight, level and plumb.

G. Installation of Elastic Flashing and Trim:
   1. Bond elastic flashing and trim sheets to vertical substrates and to other surfaces as indicated or recommended by sheet manufacturer, and seam the end joints.
   2. On bituminous membranes provide not less than 4-inches of mechanically fastened cover over built-up composition base flashings.

H. Installation of Reglets and Reglet Counterflashing:
   1. For installation of cast-in-place reglets refer to Section 03 30 00, Cast-In-Place Concrete.
   2. For installation of built-in-place masonry reglets refer to Section 04 20 00, Concrete Unit Masonry.
   3. Install surface-mounted reglets complying with manufacturer's written instructions to produce a watertight installation. Use sealant specified in Section 07 92 00, Caulking and Sealants.
   4. Install counterflashing with positive pressure against base flashing and reglet and with air break at mid-point to prevent capillary action. No screws or exposed fasteners shall be permitted in the finished Work except those required at each pre-punched hole for surface-mounted reglet attachment.
   5. End lap counterflashing horizontally a minimum of 3-inches.
   6. Overlap built-up composition base flashing with counterflashing a minimum of 4-inches vertically and fold lower edge back on itself for 1/2-inch.

3.4 FIELD QUALITY CONTROL

A. Polyvinylidene Fluoride Based Coatings: Determine conformity of flashing and trim Work requiring painted finish to the Specifications as follows:

1. The manufacturer of the flashing and trim Work shall set aside and label samples of each component of the flashing and trim Work from each production lot for the Project. Protect samples from weather.
2. Make samples of flashing and trim Work available at all times, for comparison with installed flashing and trim Work as requested by OWNER, for the full time of the warranty.
3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards conforming to ASTM D 2224.

3.5 ADJUSTMENT AND CLEANING

A. Protect flashing and trim until Final Acceptance of the Work.

B. Do not permit workmen, or others, to step directly on flashing sheets in place, or to place or move equipment over flashing and trim surfaces. Protect surfaces during installation of permanent covering work and adjoining Work.

C. Neutralize excess flux as the Work progresses with five percent to ten percent washing soda solution and rinse thoroughly.

D. Clean exposed surfaces of every substance which is visible or might cause corrosion or prevent uniform oxidation of the metal surfaces. Exercise extreme care to remove fluxes and ferrous metal particles, including welding splatter and grinding dust.

+ + END OF SECTION + +

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SECTION 07 71 00

ROOF SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all roof drainage specialties Work.
   2. The extent of the roof drainage specialties is shown on the Drawings.
   3. The types of roof drainage specialties Work required includes, but is not necessarily limited to, the following:
      a. Exposed surface-mounted polyvinylidene fluoride finished aluminum drains, sumps, and downspouts.
      b. Roof and overflow drains.
      c. All miscellaneous straps, fittings and fasteners.
      d. Welded miters, end caps, downspout elbows and downspouts.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that shall be installed with the roof drainage specialties Work.

1.2 QUALITY ASSURANCE

A. Design Criteria:
   1. Standards: Comply with applicable standards and recommendations of SMACNA, Architectural Sheet Metal Manual, for the fabrication and installation of roof drainage specialties Work, except to the extent more stringent requirements are specified.

B. Source Quality Control: Provide roof drains, drainage sumps, and downspouts as a complete unit produced by a single manufacturer specializing in the production of this type of Work, including hardware, accessories, mounting and installation components.

C. Source Quality Control: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. FS H-C-494, Coating Compound, Bituminous, Solvent Type, Acid Resistant.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Shop Drawings showing the manner of forming, jointing and securing the metal to form roof drainage specialties Work. Show expansion joint details and water-proof connections to adjoining work and at obstructions and penetrations.

2. Copies of manufacturer's specifications, recommendations and installation instructions for roof drainage specialties applications. Include manufacturer's certification or other data substantiating that the materials comply with the requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials to preclude denting, scratching or otherwise marring the surface and finish of the roof drainage specialties material.

1.5 JOB CONDITIONS

A. Scheduling: Coordinate roof drainage specialties Work with roofing, flashing, trim, and the construction of decks, parapets and other adjoining work, to provide a permanently watertight, leak-proof, secure and non-corrosive installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide aluminum sheet or strip of 5005-H154 alloy, with smooth finish; downspout thickness of 0.05-inches; sump thickness of 10 gage minimum; wall penetration of 10 gage minimum.

B. Finishes: Provide metallic dark bronze polyvinylidene fluoride finish for all Work.
   1. Product and Manufacturer: Provide one of the following:
      a. Duranar XL by PPG Industries, Incorporated.
      b. Or equal

C. Size and Profile:
   1. Downspouts: As shown on the Drawings.
   2. Drainage Sump: Size as required for proper transition and drainage.

D. Roof, Right Angled Drains, and Overflow Drains: Provide roof and right angled drains constructed of high impact ABS plastic, ultraviolet and extreme weather resistant.
   1. Grates: Domed shape, constructed of nylon with ultraviolet inhibitor and integral weir.
   2. Flexible Bellows: 3-inch and 4-inch diameter, constructed of thermoplastic rubber with Type 316 stainless steel clamping bands.

E. Miscellaneous Materials:
   1. Provide the materials and types of fasteners, solder, welding rods, coatings, separators, aluminum wall penetration, sealants, and accessory items as recommended by the sheet metal manufacturer for roof drainage specialties Work, except as otherwise shown on the Drawings.
   2. Cleats and Straps: Same metal as roof drainage specialties Work being anchored or supported.
   3. Roofing Cement: Neoprene adhesive, compatible with substrate and adjoining work.
   4. Bituminous Coating: Cold-applied asphaltic coating, FS TT-C-494, Type II, compounded for minimum thickness per coat of 15 mils (dry).

F. Product and Manufacturer: Provide one of the following:
   1. Drainage Sumps, Type R.O.D. Roof and Overflow Drains, Type S.D. Right Angle Drain with Overflow and Downspouts by W.P. Hickman Aluminum Construction Products.
   2. Or equal.

2.2 FABRICATION

A. General:
   1. The fabrication requirements for metal drainage sumps and downspout Work apply to both shop-fabricated and on-site-fabricated Work.
   2. Manufacturer's Recommendations: Except as otherwise shown on the Drawings or specified, comply with the recommendations and instructions of the manufacturer of the sheet metal being fabricated.
   3. Provide for thermal expansion of exposed items. Maintain a water-tight seal at expansion joints. Locate expansion joints at the following maximum spacings:
      a. Midpoint of run.
   4. Fabricate Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat seams with minimum exposure of solder, welds and sealant. Fold back the sheet metal to form a hem on the concealed side of exposed edges.
   5. Fabricate drainage sumps and downspouts and supports as shown on the Drawings.
   6. Support and Anchorage: Fabricate units with adequate provisions for support and anchorage, of the types required for the indicated method of installation.

B. Aluminum Drainage Sump and Downspouts: Fabricate aluminum sheet using double flat-lock seams. Rivet joints where necessary for strength. Pop rivets are not acceptable.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the supporting structure and other elements of the substrate and conditions under which the roof drainage specialties Work is to be performed and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the drainage sumps, roof and overflow drains, and downspouts. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Wherever possible, take field measurements, prior to completion of shop fabrication and finishing of metal drainage sumps and downspout Work. Do not delay job progress. Allow for erection tolerances corresponding with specified tolerances where final dimensions cannot be established before fabrication.

3.3 INSTALLATION

A. Comply with manufacturer's recommendations and installation instructions. Refer to and comply with the requirements of Section 04 20 00, Unit Masonry Construction, Section 07 55 00, Single Ply Membrane Roofing, Section 07 62 00, Flashing and Trim.

B. Protection of Aluminum from Dissimilar Materials: Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09 90 00, Painting and Coating.

C. Conceal fasteners and expansion provisions, wherever possible, in exposed Work, and locate so as to minimize the possibility of leakage. Cover and seal Work, as required, for a tight installation.

D. Provide concealed cleat-type anchorages wherever practical and arrange to relieve stresses in the roof drainage specialties Work which result from building movement and thermal expansion.

E. Splice and Expansion Units: Use 0.050-inch thick splice plates.

F. Bed flashing flanges in a bed of roofing cement or other setting compound which is compatible with adjoining work and substrate.

G. On vertical overlaps, lap sheet metal a minimum of 3-inches.

H. On sloping overlaps, of slopes of not less than 6-inches in 12-inches, lap unsealed overlaps a minimum of 6-inches.

I. For embedment of metal flanges in elastic sheet flashing or stripping, extend flanges for a minimum of 4-inches embedment.

J. Support and anchor each unit of Work in the manner shown on the Drawings, but in no case in a manner which would be inadequate for thermal expansion stresses and the normal loading of water, wind and similar loadings.

K. Install units with lines and corners true and accurate in alignment and location. Install drainage sumps to assure positive drainage to downspouts.

3.4 CLEANING AND PROTECTION

A. Protect the roof drains, metal drainage sumps, and downspouts from all damage until Final Completion.

B. Roof drains, drainage sumps and downspouts damaged before Final Completion shall be replaced with new material as specified herein, at no additional cost to OWNER.

C. Clean exposed surfaces of every substance which is visible or might cause corrosion of the metal or deterioration of the finish.

+ + END OF SECTION + +

SECTION 07 92 00

CAULKING AND SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install caulking and sealants.
   2. Extent of each type of caulking and sealant is shown on the Drawings and includes the following:
      a. All joints between concrete members and masonry.
      b. All concrete to concrete joints.
      c. All metal to metal joints.
      d. All joints between masonry and metal.
      e. All expansion joints in masonry and concrete.
      f. All control joints.
      g. All joints between reglets and flashing.
      h. All sound-sealed and air-sealed joints.
      i. As an exposed-to-view finish on the exposed face of all fire-rated sealants.
      j. On both sides of all terminations of all construction systems, specified to receive caulking and sealants, where construction system remains exposed-to-view in the finished Work.
      k. All isolation joints between equipment and other items.
      l. All joints where construction systems are discontinuous or inherently non-watertight.
      m. All locations whether or not shown on the Drawings, required to render the building watertight, except where a construction system is specified or shown as not relying upon the use of sealants in order to achieve weather and watertightness.
   3. Types of products required include the following:
      a. Two-component, urethane based, non-sag, elastomeric sealant.
      b. Two-component, urethane based, self-leveling, elastomeric sealant.
      c. Polyethylene backer rods.
      d. Miscellaneous materials and accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the caulking and sealants.
   2. Coordinate the final selection of caulking and sealants to be compatible with all calking and sealant substrates specified.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in caulking and sealant installation and with successful experience in the application of the types of materials required, and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.

B. Job Mock-ups:
   1. Prior to the installation of caulking and sealant Work, but after ENGINEER'S approval of samples, install sample of each type of caulking and sealant in areas selected by ENGINEER to show a representative installation of the caulking and sealants. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of caulking and sealant Work. Retain and protect mock-ups during construction as a standard for judging completed caulking and sealant Work. Do not alter mock-ups.
   2. Caulking and sealant Work that does not meet the standard approved on the sample areas shall be stopped, removed and replaced with new material.

C. Source Quality Control: Obtain materials from only manufacturers who will, if required:
   1. Send a qualified technical representative to the site, for the purpose of advising installer of proper procedures and precautions for the use of the materials.
   2. Test caulking and sealants for compatibility with the substrates specified for conformance to FS-TT-S-0027, and recommend remedial procedures as required.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. ASTM C 661, Test Method for Identation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   3. ASTM C 793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
   4. ASTM C 794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
   5. Federal Specification, FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component for Caulking, Sealing, and Glazing in Buildings and Other Structures.

E. Compatibility: Before purchase of each specified sealant, investigate its compatibility with the joint surfaces, joint fillers and other materials in the joint system. Provide only materials (manufacturer's recommended variation of the specified materials) which are known to be fully compatible with the actual installation condition, as verified by manufacturer's published data or certification and as shown on approved Shop Drawings.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each type of actual cured material samples of each caulking and sealant specified, 3-inches long, in each of the manufacturer's standard colors.
   2. Each size and type of sealant backer rod, 3-inches long, as recommended by the caulking and sealant manufacturer.
   3. Bond breaker tape as recommended by the manufacturer.
   4. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the responsibility of CONTRACTOR.
   5. Refer to and comply with the requirements of Section 01 33 23.15, Samples.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, recommendations and installation instructions for each type of sealant, caulking compound and associated miscellaneous material required. Include manufacturer's published data, indicating that each material complies with the requirements and is intended for the applications shown.
   2. Pre-Installation Meeting report as specified in Paragraph 1.5.A., below.

C. Test Reports: Submit for approval the following:
   1. Compatibility tests for substrates, based on adhesion-in-peel standard test procedures and FS TT-S-0027.
   2. Certified laboratory test reports indicating conformance with the requirements.

D. Guarantee: Submit for approval the following:
   1. Copies of written guarantee agreeing to repair or replace sealants which fail to perform as specified. Refer to paragraph 1.6.A of this Section.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in caulking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufacture.
      c. Mixing instructions, shelf life and curing time, when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER. Immediately remove rejected materials from the site and do not offer them again for approval by ENGINEER. Supply new material conforming to the specified requirements, at no additional expense to OWNER.

B. Storage and Handling of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Do not store or expose materials to temperature above 90°F or store in direct sunshine.
   3. Do not use materials which are outdated as indicated by shelf life.
   4. Store sealant tape in a manner which will not deform the tape.
   5. In cool or cold weather, store containers where temperature approximates 75°F for 16 hours before using.
   6. When high temperatures prevail, store mixed sealants in a cool place.
   7. Refer to and comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.
   8. Handle materials carefully to prevent inclusion of foreign materials.
   9. Do not open containers or mix components until necessary preparatory Work and priming has been completed.

1.5 JOB CONDITIONS

A. Pre-Installation Meeting:
   1. Prior to the installation of the caulking and sealants and associated Work, schedule and meet at the job site with; the calking and sealant installer, the calking and sealant manufacturer's technical representative, other trades involved in coordination with the caulking and sealant Work, the ENGINEER, and the OWNER. Record the discussions of the Pre-Installation Meeting and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures related to the caulking and sealant Work, including but not necessarily limited to the following:
      a. Review project requirements, including Drawings, Specifications and other Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review status of substrate and similar considerations.
      d. Review each major caulking and sealant application required.
      e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
   2. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

B. Environmental Conditions:
   1. Do not proceed with installation of caulking and sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   2. Proceed with the Work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
   3. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
   4. When high temperatures prevail avoid mixing sealants in direct sunlight.

C. Protection: Do not allow caulking and sealants to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or the caulking and sealant materials.

1.6 GUARANTEE

A. Provide a written guarantee agreeing to repair or replace sealants which fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data, as an inherent quality of the material for the exposure indicated. Provide guarantee signed by installer and

CONTRACTOR. Provide guarantee period of two years from Final Completion. Refer to paragraph 1.3.D.1 of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; submerged and intermittently submerged:
   1. Two-Component Polysulfide Sealant:
      a. Polysulfide-based, 2-part elastomeric sealant complying with the following:
         1) Thiokol's Building Trade Performance Specifications: Type II Class A (non-sag).
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794 (minimum 5 lbs.): Glass, minimum 21 lbs./linear inch; Aluminum, minimum 18 lbs/ linear inch; Concrete, minimum 21 lbs/linear inch.
         3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
         4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
         5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
      b. Product and Manufacturer: Provide one of the following:
         1) Sonnolastic Two-Part by Sonneborn Building Products, Division of Chemrex, Inc.
         2) Lasto-Meric by Tremco.
         3) Or equal.

B. Exterior and Interior Vertical Joints; non submerged:
   1. Two-Component Urethane Sealant:
      a. Urethane-based, 2-part elastomeric sealant complying with the following:
         1) FS TT-S-00227E: Type II (non-sag) Class A.
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794: (Minimum 5 lbs/linear inch with no adhesion failure): 28 lbs.
         3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
         4) Stain and color change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
         5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
      b. Product and Manufacturer: Provide one of the following:
         1) Sonolastic NP 2 by Sonneborn Building Products, Division of Chemrex, Inc.
         2) Dymeric by Tremco.
         3) Or equal.

C. Exterior and Interior Horizontal Joints; non submerged:
   1. Two-Component Polyurethane Sealant:

a. Polyurethane-based, 2-part elastomeric sealant complying with the following:
   1) FS TT-S-00227E, Type I (self-leveling) Class A.
   2) Water Immersion Bond, FS TT-S-00227E: Elongation of 25 percent with no adhesive failure.
   3) Hardness (Standard Conditions), ASTM C 661: 35 to 45.
   4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
   5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.

b. Product and Manufacturer: Provide one of the following:
   1) SL_2 Sealant by Sonneborn Building Products, Division of Chemrex, Inc.
   2) THC/900 by Tremco.
   3) Or equal.

D. Provide colors selected by ENGINEER from caulking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide the same generic products and colors as available from manufacturers specified.

E. Miscellaneous Materials:
   1. Joint Cleaner: As recommended by the caulking and sealant manufacturer.
   2. Joint Primer and Sealer: As recommended by the caulking and sealant manufacturer.
   3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended by the caulking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to the substrate or joint filler must be avoided for proper performance of caulking and sealant. Provide self-adhesive tape, wherever applicable.
   4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with caulking and sealant by the caulking and sealant manufacturer. Provide size and shape of rod which will control the joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backer to minimize the possibility of sealant extrusion when joint is compressed.
   5. Low Temperature Catalyst: As recommended by the calking and sealant manufacturer.

F. Silicone Sealant
   1. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
   2. Manufacturers: One of the following or equal:
      a. Tremco, Proglaze.SSG
      b. Pecora Corp., Number 864.
      c. Dow Corning, Number 795.
      d. General Electric, Number 1200 Series.

G. Acrylic-Latex Sealant

1. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound meeting the requirements of ASTM C834, colors as selected by Engineer from manufacturer's standard options:
   a. Manufacturers: One of the following or equal:
      1) Tremco, Tremflex 834.
      2) Pecora Corp., Number AC-20.

2.2 MIXING

A. Comply with sealant manufacturer's written instructions for mixing two-component sealants.
B. Thoroughly mix components before use.

C. Add entire contents of activator can to base container. Do not mix partial units.

D. Mix contents for a minimum of five minutes or as recommended by the sealant manufacturer, until color and consistency are uniform.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and the conditions under which the caulking and sealant Work is to be performed, and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the sealants. Do not proceed with the calking and sealant Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 JOINT SURFACE PREPARATION

A. Clean joint surfaces immediately before installation of sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances which would interfere with bonds of sealant compound as recommended by sealant manufacturer's written instructions as shown on approved Shop Drawings.

B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's written instructions, as shown on approved Shop Drawings, indicate that alkalinity does not interfere with sealant bond and performance.
   1. Etch with five percent solution of muriatic acid.
   2. Neutralize with dilute ammonia solution.
   3. Rinse thoroughly with water and allow to dry before sealant installation.

C. If necessary, clean porous materials such as concrete and masonry by grinding, sand blasting or mechanical abrading. Blow out joints with oil-free compressed air, or by vacuuming joints prior to application of primer or sealant.

D. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.

3.3 INSTALLATION

A. Comply with sealant manufacturer's written instructions, except where more stringent requirements are shown on the Drawings or specified and except where manufacturer's technical representative directs otherwise; but only as approved by ENGINEER.

B. Prime or seal the joint surfaces as shown on approved Shop Drawings. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to application of sealants.

C. Apply masking tape before installation of primer, in continuous strips in alignment with the joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

D. Do not install sealants without backer rods or bond breaker tape.

E. Roll the back-up rod stock into the joint to avoid lengthwise stretching. Do not twist, braid, puncture or prime backer-rods.

F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

G. Install sealants to depths as recommended by the sealant manufacturer, but within the following general limitations, measured at the center (thin) section of the bead.
   1. For horizontal joints in sidewalks, pavements and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
   2. For vertical joints subjected to normal movement and sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

H. Remove excess and spillage of compounds promptly as the Work progresses.

I. Cure caulking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

3.4 FIELD QUALITY CONTROL

A. Where questions of compatibility of sealants and substrate arise, the sealant manufacturer shall test the substrate in question for compatibility with the specified sealant and report his findings, along with recommendations, to ENGINEER.

B. Do not proceed with installation of elastomeric sealants over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227 has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

C. After nominal cure of exterior joint sealants which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, 2 feet - 0 inch from joint and connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.

D. Test approximately five percent of total joint system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct test in the presence of ENGINEER, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

E. Where nature of observed leakage indicates the possibility of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion of the Work.

3.5 ADJUSTMENT AND CLEANING

A. Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation.

B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by the sealant manufacturer. Leave all finish Work in a neat and clean condition.

C. Protect the sealants during the construction period so that they will be without deterioration, soiling, or damage at the time of Final Completion.

3.6 SCHEDULE

A. Acrylic latex:
   1. Use where indicated on the Drawings.
   2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

B. Silicone:
   1. Use where indicated on the Drawings.

2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
3. Door threshold bedding.
4. Moist or wet locations, including joints around plumbing fixtures.
5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
6. Plenum joints.

C. Multi Part Polyurethane, non-sag Type II:
1. Use where indicated on the Drawings.
2. Water-bearing and earth-bearing concrete structures.
3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
4. Joints between sheet metal flashing and trim.
5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
8. Expansion and control joints in masonry vertical surfaces.

D. Multi Part Polyurethane, self-leveling Type I:
1. Use where indicated on the Drawings.
2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
4. Pavement joints.
5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

+ + END OF SECTION + +

SECTION 08 06 10

DOOR SCHEDULE

DOOR SCHEDULE:												
DOOR NO.	**ROUGH WIDTH**	**OPENING HEIGHT**	**TYPE**	**DOORS WIDTH**	**FRAME HEIGHT**	**MAT'L**	**TH**	**VP**	**TYPE**	**MAT'L**	**UL**	**REMARKS**
100-A	6’-0”	7’-0”	D	5’-8”	7’-4”	G.STL	1-3/4”	-	B/D	G.STL		
100-B	6’-0”	7’-0”	D	5’-8”	7’-4”	G.STL	1-3/4”	-	B/D	G.STL		
101	3’-4”	7’-0”	A	3’-0”	7’-4”	G.STL	1-3/4”	-	B	G.STL		

DOOR TYPES

A. Single door.
B. Single door with 2-foot by 2-foot vision panel.
C. Double door.

FRAME TYPES

A. 1-3/4-inch by 5-inch.
B. 2-inch by 8-3/4-inch.
C. G.STL. angle curtain guide assembly with windlock guide.
D. 2-1/2-inch by 5-3/4-inch window wall system with 1-inch tinted insulating glass.

ABBREVIATIONS

- VP Vision Panel
- NO. Number
- MAT'L Material
- TH Thickness
- UL Underwriters' Laboratory, Incorporated
- G.STL. Galvanized Steel

- S.STL. Stainless Steel
- ALUM Aluminum

+ + END OF SECTION + +

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SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install hollow metal doors and frames.
   2. Extent of hollow metal doors and frames is shown on the Drawings.
   3. Types of products required include the following:
      a. galvanized steel, paper honeycomb core, internally-reinforced, flush doors.
      b. galvanized steel, paper honeycomb core, internally-reinforced, fire-rated, flush doors.
      c. Fully welded, galvanized steel, internally-reinforced, door frames.
      d. Fully welded, galvanized steel, fire-rated, internally-reinforced, door frames.
      e. Knocked-down, mitered corner, galvanized steel, drywall frames.
      f. Knocked-down, mitered corner, galvanized steel, fire-rated, drywall frames.
      g. Interior stick system window frames, sidelights and partitions.
      h. Fire-rated, interior stick system window frames, sidelights and partitions.
      i. Sound-retardant doors and frames.
      j. Transoms and panels.
      k. Fire-rated transoms and panels.
      l. Removable panels.
      m. Removable transoms.
      n. Miscellaneous supports; special, supplemental and standard finish hardware reinforcements and preparation items; fasteners and accessories; all for high-frequency, high-endurance use.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Provide hollow metal doors and frames and accessories manufactured by a single firm specializing in the production of this type of Work and complying with specified standards of ANSI, NFPA, SDI and UL.
   2. Provide hollow metal doors and frames from a manufacturer who is a member of SDI.

B. Requirements of Regulatory Agencies:
   1. Fire-resistance-rated Assemblies: Wherever a fire-resistance classification is shown on the Drawings or scheduled for hollow metal doors and frames (3 hour, 1-1/2 hour, and similar designations), provide fire-resistance-rated hollow metal doors and frames tested as a fire door assembly, complete with type of fire door hardware to be used.
   2. Identify each fire-resistance-rated door and frame with recognized testing laboratory labels, indicating applicable fire-resistance-rating of both door and

frame. Provide fire-resistance-rated doors and frames with metal labels permanently fastened to door and frame. Labels shall display all UL required information.

3. Temperature Rise Rating: Where required by the Phoenix Building Code, provide fire-resistance-rated doors as shown on the drawings and in accordance with NFPA 80, Standard for Fire Doors and Fire Windows. Where temperature-rise-ratings are required by Phoenix Fire Code or NFPA 80, provide doors with the required temperature-rise-rating in accordance with UL 10B, Fire Tests of Doors and Assemblies.
   a. For a UL 3-hour (A) classification, provide doors with a temperature rise rating of not more than 250°F maximum to 30 minutes of exposure.
   b. For a UL 1-1/2 hour (B) classification, provide doors with a temperature rise rating of not more than 450°F or 650°F maximum to 30 minutes of exposure.
4. Oversize Assemblies: Wherever hollow metal assemblies are larger than size limitations established by ANSI/NFPA 252 and UL 10 B provide manufacturer's certification that assembly has been constructed with materials and methods equivalent to labeled construction.

C. Allowable Tolerances: Provide door and frame manufacturing tolerances in compliance with SDI-117 and as follows:
1. Nominal Clearance Between Door and Frame Head and Jamb: 1/8-inch.
2. Nominal Clearance Between Meeting Edges of Pairs of Doors: 1/8-inch.
3. Nominal Clearance at Bottom of Door: 3/4-inch.
4. Nominal Clearance Between Face of Door and Door Stop: 1/16-inch.
5. Provide all Work plumb and true to adjoining surfaces with all miters and copes accurately formed.
6. Provide completely water- and vapor tight joints.

D. Codes: Comply with applicable requirements of the Phoenix Building Code.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. ANSI in association with Door and Hardware Institute, A115.1-A115.17/DHI, Specifications for Steel Door and Frame Preparation for Hardware.
2. ANSI A224.1, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
3. ANSI A250.3, Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
4. ANSI A250.4, Test Procedures and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.
5. ANSI A250.5, Accelerated Physical Endurance Test Procedure for Steel Doors, Frames, and Frame Anchors.
6. ANSI/NFPA 252, Fire Tests of Door Assemblies.
7. ANSI in association with Steel Door Institute, ANSI/SDI 100, Steel Doors and Frames.
8. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
9. ASTM A 366, Specification for Commercial Steel Sheet, Carbon, Cold-Rolled Sheet.

10. ASTM A 653, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by The Hot-Dip Process.
11. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
12. ASTM E 1408, Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.
13. NFPA 80, Standard for Fire Doors and Fire Windows.
14. Steel Door Institute, SDI 105, Recommended Erection Instructions for Steel Frames.
15. Steel Door Institute, SDI 106, Recommended Standard Door Type Nomenclature.
16. Steel Door Institute, SDI 112, Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
17. Steel Door Institute, SDI 117, Manufacturing Tolerances Standard Steel Doors and Frames.
18. Steel Door Institute, SDI 122, Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
19. Steel Door Institute, SDI 128, Guidelines for Acoustical Performance of Standard Steel Doors and Frames.
20. SSPC-Paint 2, Cold Phosphate Surface Treatment.
21. SSPC-Paint 27, Basic Zinc Chromate-Vinyl Butyral Wash Primer.
22. Underwriters Laboratories Incorporated, Standards for Safety, UL 10B, Fire Tests of Door Assemblies.
23. Door and Hardware Institute, DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
24. Phoenix Building Code.

1.3 SUBMITTALS

A. Samples: When requested submit for approval the following:
   1. Pressed metal corner section of frame, 12-inches by 12-inches minimum, showing all special, supplemental and standard reinforcements, attachments, supports and anchors specified. Provide corner sample for each type of frame specified. Refer to and comply with the requirements of Section 01 33 23.15, Samples.
   2. Stick system components showing corner detail and glazing stops of all types specified, 12-inches by 12-inches, minimum.
   3. Cut-away section of all door types specified, showing internal construction, edge details and reinforcements for butts, closers and similar items of finished hardware, 2 foot-0 inches by 2 foot-0 inches minimum. Include louver sections, vision panel and glazing stops.

B. Shop Drawings: Submit for approval the following:
   1. Fabrication and installation drawings of hollow metal doors and frames. Include details of each frame type, elevations of each door type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints, connections and every composite member. Show all door and frame reinforcements, including welds, plate lengths, locations and gages, identified for each component of finish hardware, specified in Section 08 70 00, Hardware.

2. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown on the Drawings and Section 08 06 10, Door Schedule.

C. Test Reports:
1. Laboratory test report for required performance and specified feature verification for doors and frames selected at random by ENGINEER for testing.
2. Sound Retardant Doors and Frames: Laboratory test reports, verifying performance requirements for each type of unit required.
3. Test reports indicating compliance with ANSI A250.4 and ANSI A250.5.

1.4 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver hollow metal doors and frames cartoned or crated to provide protection during transit and job storage.
2. Inspect hollow metal doors and frames for damage upon delivery. Minor damage may be repaired provided the finish items are equal in all respects to new work and acceptable to ENGINEER; otherwise, remove and replace damaged items.

B. Storage and Handling of Materials:
1. Store doors and frames at the site under cover.
2. Place units up off floors in a manner that will prevent rust and damage.
3. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If cardboard wrapper on the door becomes wet, remove the carton immediately.
4. Provide a 1/4-inch space between stacked doors to promote air circulation.
5. Materials and Equipment.

1.5 JOB CONDITIONS

A. Scheduling:
1. Coordinate with other Work by furnishing approved Shop Drawings, inserts and similar items at the appropriate times for proper sequencing of construction without delays.
2. Do not install doors and frames until all Work which could damage doors and frames has been completed.
3. Provide temporary doors until construction sequencing allows installation of permanent doors and frames.
4. Do not proceed with the installation of permanent hollow metal doors until CONTRACTOR provides finished Work complying with all requirements of the Specifications.

B. Protection:
1. Protect built-in frame Work with temporary wood protection.

1.6 GUARANTEE

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Door Classification: Provide hollow metal doors of Grades and Models in accordance with ANSI/SDI 100, and ANSI A250.5 as follows:
      a. Level 1 Model 2

B. Door and Panel Construction:
   1. Provide doors of two outer stretcher-leveled sheets, 16 ga. minimum. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces, except around glazed or louvered panel inserts. No fillers shall be used. Provide weep hole openings in the bottom of exterior doors to permit the escape of entrapped moisture.
   2. Reinforce inside of doors with honeycomb core completely filling the inside of the door and laminated to the inside of both face panels with an adhesive. The honeycomb material shall have a crushing strength not less than 6,000 pounds per square foot and the lamination shall withstand not less than 1,100 pounds per square foot in shear.

C. All building exterior man doors shall be of a minimum four-hinge type.

D. Frame Construction:
   1. Form frames of cold-rolled sheet material, 14 ga. minimum. Provide seamless frames for all Work, unless specifically specified and shown on the Drawings as permitting exposed fasteners.
   2. Provide hollow metal frames for doors, transoms, side-lights, borrowed lights, and other openings of size and profile as shown on the Drawings or specified.
   3. Provide sound-retardant frames with an asphaltic-based sprayed-on paint or other approved noncombustible material lining the entire inner surface of the frames.
   4. Provide drywall frames, knock-down-type with exposed adjusting anchor screws in all gypsum wallboard metal stud partitions. Refer to and comply with the requirements of Section 09 29 00, Gypsum Board and Section 06 10 00, Rough Carpentry.
   5. Provide stick system for interior window frames and partitions, assembled as borrowed lights, sidelights, transom frames, or interior windows assembled from components of same gage, and of similar profiles to standard hollow metal door frames, as shown on the Drawings.

2.2 MANUFACTURERS

A. Product and Manufacturer: Provide one of the following:
   1. Steelcraft
   2. Ceco
   3. Republic
   4. Curries
   5. Or equal

2.3 MATERIALS

A. Door Faces and Frames: Zinc-coated, cold-rolled carbon steel sheets of commercial quality, complying with ASTM A 366, and ASTM A 653, G 60 zinc coating, mill- phosphatized.

B. Honeycomb Core: Phenolic resin-impregnated, nominal 1-inch hexagonal cell size, one piece, Kraft fiber core board, with 42 psi minimum crushing strength.

C. Supports and Anchors: Formed sheet metal, hot-dip galvanized after fabrication complying with ASTM A 153, Class B, and in compliance with requirements of ANSI A250.5. Provide supports and anchors as follows:
   1. Jamb Anchors: 16-gage minimum, and of the following types:
      a. Masonry Construction: Adjustable, corrugated or perforated, T-shaped to suit frame size with leg not less than 2-inches wide by 10-inches long.
      b. In-Place Concrete or Masonry Construction: 3/8-inch concealed bolts and expansion shields or inserts.
      c. Gypsum Wallboard and Steel Stud Construction: Two-piece compression anchors with exposed compression fasteners.
   2. Floor and Head Anchors: 14-gage minimum, and of the following types:
      a. Monolithic Concrete Slabs: Clip-type, with two holes to receive fasteners, welded to bottom of jambs and mullions.
      b. Separate Topping Concrete Slabs: Adjustable-type with extension clips, allowing not less than 2-inches height adjustment. Terminate bottom of frames at finish floor surface.

D. Inserts, Bolts and Fasteners: Sheet metal hot-dip galvanized complying with ASTM A 153, Class C or D as applicable.

E. Miscellaneous Accessories:
   1. Head Strut Supports: 3/8-inch by 2-inch hot-dipped galvanized steel.
   2. Structural Reinforcing Members: Provide structural reinforcing members as part of frame assembly, where shown on the Drawings at mullions, transoms, or other locations that are to be built into frame.
   3. Head Reinforcing: For frames over 4 feet-0 inch wide, in masonry openings, provide continuous steel channel or angle stiffener, not less than 12-gage for full width of opening, welded to back of frame at head.
   4. Shipping Bars: Provide removable shipping bar across bottom of frames, tack welded to jambs and mullions.
   5. Plaster Guards: 26-gage minimum galvanized steel.
   6. Louvers, Stops and Moldings: 16-gage minimum, cold-rolled, hot-dipped galvanized, formed sheet metal.
   7. Insect Screen: 14 by 18 bronze wire mesh in a rigid, formed metal frame.

2.4 FABRICATION

A. General:
   1. Fabricate hollow metal units to be rigid, neat in appearance and free for defects, warp or buckle. Accurately form metal to required sizes and profiles.
   2. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify Work that cannot be permanently factory-assembled before shipment, to assure proper assembly at the site. Weld exposed frame joints continuously, grind, dress, and make smooth, flush and invisible.

3. Exposed Fasteners: Unless otherwise shown on the Drawings or specified, do not use exposed fasteners in the Work. Where exposed fasteners are shown or specified, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

B. Doors:
   1. Fabricate all hollow metal doors and panels in compliance with ANSI A250.5.
   2. Fabricate all doors with flush top and bottom closing channel, without exposed fasteners. Reinforce tops and bottoms of doors with inverted, flush-mounted, minimum 20-gage, horizontal steel channels fastened to internal reinforcement channel and with 20-gage closing plate spot welded to closure channel. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels and plates.
   3. Hollow Metal Panels:
      a. Fabricate hollow metal panels of the same materials, construction, and finish as specified for hollow metal doors.
      b. Provide astragal integral with top of door where shown on the Drawings.
   4. Provide dutch doors with shelves as shown on the Drawings.
   5. Edge profiles shall be provided on both stiles of doors beveled 1/8-inch in 2-inches.

C. Frame Construction:
   1. Fabricate all hollow metal frames in compliance with ANSI A250.5 and as specified.
   2. Fabricate frames with reinforced, mitered corners, that are continuously arc-welded for the full depth and width of the frame, with bottom shipping bar; except provide drywall frames as specified.
   3. Grind all exposed welds flush and smooth.
   4. Knock-down-type frames shall be used for drywall construction only and shall provide the following additional features:
      a. Specifically designed for drywall construction.
      b. Frames shall be knocked down, designed to be securely installed in the rough opening after the wallboard is applied.
      c. Jamb and head connection shall be a neat, flush, miter with head securely locked to top of jamb.
      d. Mitered corners shall be reinforced with a concealed corner cup to provide a firm interlock of jamb to head.
      e. Provide two anchors at head of frames exceeding 3 foot-6 inches wide.
      f. Provide vertical steel head support struts extending from top of frame at each jamb to supporting construction above. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
   5. Mullions and Transom Bars:
      a. Provide closed mullions and transom bars where shown on the Drawings. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.
      b. Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.
   6. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at the top so they can be filled with grout.

7. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
8. Head Anchors: Provide two anchors at head of frames exceeding 3 foot-6 inches wide for frames mounted in drywall partitions.
9. Head Strut Supports: Provide vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
10. Rubber Door Silencers: Drill stop to receive three silencers on single-door frames and four silencers on double-door frames. Install plastic plugs to keep holes clear during construction.
11. Plaster Guards: Provide manufacturer's standard plaster guards or dust cover boxes.

D. Finish Hardware Preparation:
   1. General:
      a. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with approved Finish Hardware Schedule and templates provided by finish hardware supplier and as specified. Comply with applicable requirements of ANSI/DHI A115.1 - A115.17 and ANSI A250.4. Refer to Section 08 70 00, Hardware.
      b. Obtain approved Finish Hardware Schedule, hardware templates, and samples of finish hardware where necessary to ensure correct detailing and fabrication of the hollow metal doors and frames, from finish hardware supplier.
   2. Doors:
      a. Preparation includes sinkages, and cut-outs for mortised and concealed finish hardware and reinforcements for both concealed and surface-applied finish hardware.
      b. Drill and tap mortise reinforcements at factory, using templates.
      c. Detail and fabricate reinforcements with concealed connections designed to develop full strength of reinforcements for high-frequency applications.
      d. Reinforce doors for required finish hardware, with minimum gages of reinforcements provided as follows:
         1) Hinges: Steel plate 3/16-inches thick by 1-1/2-inches wide by 6-inches longer than hinge and secured by not less than six spot or projection welds with top hinge further reinforced with a high-frequency back-up reinforcement.
         2) Mortise Locksets and Dead Bolts: 12-gage steel sheet, secured with not less than four spot or projection welds.
         3) Cylinder Locks: 12-gage steel sheet, secured with not less than two spot or projection welds.
         4) Flush Bolts: 12-gage steel sheet, secured with not less than two spot or projection welds.
         5) Surface-Applied Closers and Overhead Stops: 12 ga. steel plate, not less than 10-inches long, secured with not less than six spot or projection welds.
         6) Push Plates and Bars: 16-gage steel sheet secured with not less than two spot or projection welds.

7) Surface Panic Devices: 16-gage sheet steel secured with not less than two spot or projection welds.
8) Automatic Door Bottoms: Reinforce for mortise-type units with 14-gage steel, and 16-gage for surface-applied units.

3. Frames:
   a. Reinforce frames for required finish hardware with minimum gages as follows:
      1) Hinges and Pivots: Special full width of frame, 7 ga. thick steel plate by 8-inches longer than hinge, secured to both rabbets by not less than twelve spot or projection welds.
      2) Strike Plate Clips: 10-gage steel plate by 1-1/2-inches wide by 3-inches long with mortar guard boxout secured with not less than six spot or projection welds.
      3) Surface-Applied Closers: 3/16-inch steel plate, secured with not less than six spot or projection welds. Coordinate closer function and presence of overhead stops and weather-stripping, with location of reinforcement plate.
      4) Concealed Closers: Removable steel access plate, 12-gage internal reinforcement of size and shape required, and enclosing housing to keep closer pocket free of mortar or other materials.

E. Door Louvers:
   1. Fabricate louvers and mount flush into doors without overlapping moldings on surface of door-facing sheets. Provide internal support as recommended by louver manufacturer. Provide profile as shown on the Drawings.
   2. Interior Louvers: Sightproof, stationary type, constructed of inverted chevron-shaped blades and U-shaped frames, not less than 1-3/8-inches thick, formed of 18-gage cold-rolled steel. Space louver blades not more than 3-inches on center. Assemble units by welding.
   3. Exterior Louvers: Fabricate units with stationary, weatherproof Z-shaped blades and U-shaped frames, not less than 1-3/8-inch thick. Space louver blades not more than 1-1/2-inches on center. Assemble units by welding. Provide removable insect screens on the interior side of the frame.
   4. Louvers for Fire-Resistance-Rated Openings: Provide tightly fitted, equipped with fusible links, arranged so that metal overlaps metal at every joint, UL approved.

F. Stops and Moldings:
   1. Provide stops and moldings around solid, glazed and louvered panels in hollow metal units and in frames to receive glass.
   2. Fabricate fixed stops and moldings integral with frame. Provide fixed stops on inside of hollow metal units exposed to exterior and on corridor side of interior units.
   3. Provide removable stops and molds at other locations, formed of not less than galvanized 20-gage steel sheets. Secure with countersunk machine screws spaced uniformly not more than 12-inches on center. Form corners with butted hairline joints.
   4. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated.

2.5 SHOP PAINTING

A. Clean, treat and paint exposed surfaces of fabricated hollow metal units, including galvanized surfaces.

B. Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before the application of the shop coat of paint.

C. Refer to Section 09 90 00, Painting and Coating, for field-applied primer and finish paint for exterior or interior exposed ferrous, non-ferrous, or galvanized surfaces.

D. Apply shop-coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 1.5-mils.

E. Finish shall be rust inhibitive primer capable of passing a 500 hour salt spray and a 1,000 hour humidity test in accordance with ASTM B 117 as certified by an independent laboratory.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which hollow metal doors and frames are to be installed and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Frames that are bowed, twisted or otherwise unacceptable shall be removed from the site and replaced with properly constructed frames.

3.2 PREPARATION

A. Drilling and tapping for surface-applied finish hardware may be done at site.

B. Protective Coating: Protect inside, concealed, faces of door frames in plaster or masonry construction using fibered asphalt emulsion coating. Apply over shop primer approximately 1/8-inches thick and allow to dry before installation.

3.3 INSTALLATION

A. Install hollow metal units and accessories in accordance with approved Shop Drawings, SDI 105 and as shown on the Drawings and specified.

B. Placing Frames:
   1. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.
   2. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and shipping leaving surfaces smooth and undamaged.
   3. Make field splices in frames as detailed on approved Shop Drawings, welded and finished to match factory work.

C. Setting Masonry Anchorage Devices:
   1. In masonry construction, building in of anchors and grouting of frames is included in Section 04 20 00, Unit Masonry.
   2. Set anchorage devices opposite each anchor location, in accordance with details on approved Shop Drawings and anchorage device manufacturer's instructions as follows:
      a. Masonry Walls: Install at least three jamb anchors per jamb up to 7 feet-6 inches height; four anchors up to 8 feet-0 inch jamb height; one additional anchor for each 2 foot-0 inch or fraction thereof over 8 feet-0 inch height.
      b. Cast-In-Place Concrete and Existing Rough Openings: Anchor frame jambs with concealed bolts into expansion shields or inserts at 6-inches from top and bottom and 2 foot-0 inches on center. Apply removable stop to cover anchor bolts.
      c. Structural Steel: Secure frames to structural steel framing using machine bolts inserted through tubular steel pipe sleeves reinforcement concealed in hollow metal frames at 6-inches from top and bottom and 2 foot-0 inches on center. Apply removable stop to cover anchor bolts.
      d. Steel Stud Construction: Secure knocked-down-type drywall frames to gypsum wallboard metal studs using compression anchor assemblies. Install at least three jamb anchors per jamb up to 7 feet-6 inches height; four anchors up to 8 feet-0 inch jamb height; one additional anchor for each 2 foot-0 inch or fraction thereof over 8 feet-0 inch height.
   3. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on approved Shop Drawings.

D. Door Installation:
   1. Fit hollow metal doors accurately in their respective frames, with the following clearances:
      a. Jambs and Head: 3/32-inch.
      b. Meeting Edges, Pairs of Doors: 1/8-inch.
      c. Bottom: 3/4-inch, where no threshold or carpet.
      d. Bottom: At threshold or carpet, 1/8-inch.
   2. Place fire-resistance-rated doors with clearances as specified in NFPA Standard No. 80.
   3. Finish hardware installation is specified under Section 08 70 00, Hardware. Locate finish hardware as shown on approved Shop Drawings, in accordance with hardware templates provided by finish hardware manufacturers and in accordance with Door and Hardware Institute, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.

3.4 ADJUSTMENT AND CLEANING

A. Check and readjust operating finish hardware items in hollow metal door and frame Work just prior to final inspection. Leave Work in complete and proper operating conditions.

B. Where problems of installation or damage are cause for rejection of hollow metal door and frame Work, consult SDI-122 and the recommendations of the hollow metal door and frame manufacturer, for suggestions concerning required adjustments in the Work. Submit recommendations to ENGINEER for approval.

Replace and repair unacceptable Work, as directed by ENGINNER, so that there will be no doubt as to the acceptability of the Work at the time of Substantial Completion.

C. Prime Coat Touch-Up: Immediately after installation, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

D. Provide protective treatment and other precautions required as recommended by manufacturer, through the remainder of the construction period, to ensure that doors and frames will be without damage or deterioration (other than normal weathering) at the time of Final Acceptance.

+ + END OF SECTION + +

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SECTION 08 31 00

ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all access doors and panels Work.
   2. Extent of access doors and panels is shown on the Drawings.
   3. Types of products required include the following:
      a. Wet Well access hatch/equipment hatch.
      b. Miscellaneous hardware, accessories and fasteners.

B. Coordination:
   1. Furnish inserts and anchoring devices, which must be built into other work for the installation of access doors and panels.

C. Definitions:
   1. Clear Opening Size: Space within the opening having no obstructions. Furnish model that will provide the minimum clear opening indicated.
   2. Standard Duty: Will support live load of 150 PSF.
   3. Heavy Duty: Will support live load of 300 PSF.
   4. H-20 loading: As defined in AASHTO Guidelines.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. ASTM A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   6. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   7. ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   8. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   9. ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical data and installation instructions for each type of access door and panel assembly.
      a. Transmit copy of each instruction to the installer.
      b. Provide setting drawings, templates, instructions and directions for installation of anchorage devices.
      c. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. Materials:
   1. General: Provide access door and panel assemblies manufactured as integral units and complete with all components and accessories ready for installation.
   2. Aluminum:
      a. Sheet and Plate: ASTM B209.
      b. Extruded shapes: ASTM B221.
   3. Steel:
      a. Sheet Metal: G90 Galvanized, ASTM A653/A653M.
      b. Fabrications: Hot-Dip Galvanized, ASTM A123/A123M.
      c. Hardware: Hot-Dip Galvanized, ASTM A153/A153M.
   4. Stainless Steel: ASTM A240/A240M or A666.
   5. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
      a. Wet Well access hatch/equipment hatch:
         1) The BILCO Company.
         2) Babcock-Davis.
         3) Dur-Red Products.
         4) USF Fabrication by Eagle Manufacturing Company.
         5) Or equal.

B. Manufactured units:
   1. General:
      a. All access doors shall be provided by the same manufacturer when possible.
      b. Coat all aluminum components in contact with concrete with manufacturer's standard bituminous coating.
   2. Wet Well access hatches:
      a. Frame:
         1) 1/4 IN mill finish aluminum, gutter profile, weather sealed with continuous gasket, with integral drainage coupling and perimeter gasket. Contractor shall route drain pipe from coupling to outside the vault.
            a) 1-1/2 IN DIA drain coupling.
         2) Fabricate frame with built-in neoprene cushion and strap anchors bolted to exterior.

b. Cover:
1) AASHTO H-20 wheel loading rated.
1) 1/4 IN mill finish aluminum.
2) Reinforce cover with aluminum stiffeners.
a. Live load: 300 PSF.
b. Deflection: Maximum 1/150 of span.
c. 1/2 IN by 1-1/4 IN neoprene gasket full perimeter of cover.
3) Fabricate doors to open to 90 DEG and automatically lock into open position.
4) Deflection: Maximum 1/150 of span.
c. Hardware:
1) All hardware to be stainless steel.
2) Positive hold open arm that engages automatically when door reaches full 90 DEG open position.
3) Slam lock and removable key handle.
4) Bolt hinges to underside of door.
d. Size: As indicated on the Drawings.

3. Wet Well equipment hatches:
a. Frame:
1) 1/4 IN mill finish aluminum channel with anchor tabs.
2) 1-1/2 IN DIA drain coupling.
b. Cover:
1) AASHTO H-20 wheel loading rated.
2) 1/4 IN mill finish aluminum.
3) Reinforce cover with aluminum stiffeners.
a. Live load: 300 PSF.
b. Deflection: Maximum 1/150 of span.
c. 1/2 IN by 1-1/4 IN neoprene gasket full perimeter of cover.
2) Fabricate doors to open to 90 DEG and automatically lock into open position.
3) Deflection: Maximum 1/150 of span.
c. EPDM gasket.
d. Hardware:
1) All hardware to be stainless steel.
2) Positive hold open arm that engages automatically when door reaches full 90 DEG open position.
3) Slam lock and removable key handle.

4. Operating Mechanism:
a. Adjustable counterbalancing springs, heavy-duty hold-open arm that automatically locks door open at 90 degrees, release handle with vinyl grip that allows for one-handed closure, and recessed lift handle. Operating handles allowing inside and outside operation.
b. Size(s): Refer to the SCHEDULES Article in PART 3 of this pecification Section.

C. Accessories:
1. Secondary Fall Protection System:
a. Design and install system such that when in the open position, no part of the system obstructs the clear opening size.
b. Platform: Design grating to meet OSHA 29 CFR 1910.23 requirements for protection for floor openings.
c. Finish:

1) Powder coated.
2) Color: Safety Orange or Safety Yellow.

d. Hardware:
1) Stainless steel Type 316.
2) Tamper proof Type 316 stainless steel bolts.

e. Provide positive latch to hold grating in upright position.
f. Size: Allow 6 IN clear space on each unhinged side for visual observation.
g. Provide padlock hasp for Owner provided padlock.
h. Double leaf openings:
1) Provide two individual grating platforms independent from one another.
2) Provide each platform with a padlock hasp and positive latch to hold grating in upright position.

i. Install secondary fall protection system at the factory.

2. Load Rating Plates:
a. Minimum 18 GA Type 316 stainless steel, ASTM A666.
b. Engraved with maximum design live load allowed for unit on which it will be mounted.
c. Display load in English units as well as metric units.
d. Size as required for text as needed.
e. Text:
1) Font: Helvetica Narrow, all caps.
2) Size: 1/4 IN height.
3) Depth of engraving: 3 MILS.

f. Finish:
1) Text: Black epoxy baked on paint.
2) Plate to have finish conductive to paint application.
3) Coat entire plate with baked on clear coat on front and back side.

g. Attach to top of access doors using stainless steel screws in location determined by manufacturer.
h. Provide a neoprene gasket under the plate to separate the stainless steel from the aluminum cover or frame.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which access doors are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Comply with manufacturer's instructions for installation of access doors and panels.

B. Coordinate installation with work of other trades.

C. Provide plug for drainage coupling to prevent odors from escaping through drain into drainage channel frame.

3.3 SCHEDULES

DOOR NO.	DRAWING NO.	LOCATION	CLEAR OPENING SIZE (a)	TYPE	REMARKS
WAD- 10001	M-13 and S-10	Equipment Hatch for Wet Well Pumps	5 FT-0 IN x 10 FT-6 IN	Double Leaf	a, b
WAD- 10002	M-13 and S-10	Equipment Hatch for Wet Well Pumps	5 FT-0 IN x 10 FT-6 IN	Double Leaf	a, b
WAD- 10003	M-13 and S-10	Equipment Hatch for Wet Well Pumps	5 FT-0 IN x 10 FT-6 IN	Double Leaf	a, b
WAD- 10004	M-13 and S-10	Wet Well Access Hatch	3 FT-0 IN x 5 FT-0 IN	Double Leaf	a, b
WAD- 10005	M-13 and S-10	Wet Well Access Hatch	3 FT-0 IN x 5 FT-0 IN	Double Leaf	a, b

2. Notes:
   a. See definition of Clear Opening Size in the DEFINITIONS Article in PART 2 of this Specification Section.
   b. Provide secondary fall protection system.

3.4 ADJUSTMENT AND CLEANING

A. Adjust hardware and panels after installation for proper operation.

B. Remove and replace panels or frames, which are warped, bowed or otherwise damaged.

+ + END OF SECTION + +

SECTION 08 70 00

HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install finish hardware.
   2. Extent of finish hardware is specified. Finish hardware is defined to include all items known commercially as finish hardware, except special types of unique and non-matching hardware specified in the same Section as the door and doorframe.
   3. Types of products required:
      a. Mortise Hinges.
      b. Bored Lock and Latch Sets.
      c. High-Security Mortise Locks and Latch Sets.
      d. Panic Exit Devices.
      e. Removable Mullions.
      f. Overhead Surface-Mounted Door Closers.
      g. Heavy-Duty, Concealed Overhead Holders and stops.
      h. Door Pulls, Push and Protection Armor.
      i. Stripping and Seals.
      j. Thresholds.
      k. Silencers.
      l. Wall and Floor Stops.
      m. Miscellaneous items and accessories for a complete installation functioning in compliance with the requirements of governing authorities having jurisdiction at the Site.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the finish hardware.
   2. Coordinate the Work of other Sections to provide clearances and accurate positioning of recessed or cast-in-place items.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Provide finish hardware and accessories manufactured by firms specializing in the production of this type of Work and complying with specified standards of ANSI, BHMA, DHI, NFPA, HMMA, SDI and UL.
   2. Provide finish hardware from manufacturers who are members of BHMA and participate in BHMA certification programs.

B. Installer Qualifications: The finish hardware installer shall have in his employ an architectural hardware consultant. The architectural hardware consultant shall be a member of the Door and Hardware Institute, who has passed the DHI certification

examine and successfully completed an apprenticeship program. The architectural hardware consultant shall be responsible for preparing finish hardware schedules and Shop Drawings and be present at the site for the purpose of checking and supervising the Work of the installer during the time of installation and adjustment of the finish hardware Work, and shall prepare a written field report on status of completed finish hardware installation as specified.

C. Performance Criteria:
   1. Where the finish, shape, size, fire-resistance-rating, frequency of use, or function of a member receiving finish hardware is such as to prevent, or make unsuitable, the types of finish hardware specified, furnish similar types having as nearly as practicable the same operation but of type or kind more appropriate to the design intention and requirements of governing authorities having jurisdiction. Clearly identify and highlight to ENGINEER all such required modifications on Shop Drawings submitted for approval.
   2. If finish hardware for any location is not specified, provide finish hardware equal in design and quality to adjacent finish hardware specified for comparable openings at no additional cost to OWNER.
   3. Furnish finish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
   4. Unless otherwise specified, comply with DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames and Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.

D. Requirements of Regulatory Agencies:
   1. Provide finish hardware for fire-resistance-rated openings in compliance with NFPA 80.
   2. Provide only finish hardware which has been tested, listed and labeled by UL for the types and sizes of doors required, and complies with the requirements of the door and door frame labels.
   3. Modify features of finish hardware items specified, and provide additional accessories and features as required to meet UL and NFPA requirements, at no additional cost to OWNER.

E. Codes: Comply with applicable requirements of the 2018 Phoenix Building Construction Code and adopted amendments.

F. Source Quality Control:
   1. Obtain each type of finish hardware item from only one manufacturer.
   2. Provide Finish Hardware Schedule, for submission to, and for approval by, ENGINEER, prepared in compliance with DHI standards.
   3. Comply with specified BHMA standards.

G. Reference Standards: Comply with the applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. ANSI A117.1, Accessible and Usable Buildings and Facilities.
   2. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.1, Butts and Hinges.

3. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.3, Exit Devices.
4. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.4, Door Controls - Closers.
5. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.6, Architectural Door Trim.
6. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.7, Template Hinge Dimensions.
7. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.8, Door Controls - Overhead Stops and Holders.
8. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.13, Locks and Latches, Mortise.
9. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.16, Auxiliary Hardware.
10. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.18, Hardware - Materials and Finishes.
11. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.21, Thresholds.
12. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.22, Door Gasketing Systems.
13. ANSI in association with National Fire Protection Association, ANSI/NFPA 252, Fire Tests of Door Assemblies.
14. ANSI in association with Underwriters Laboratories Incorporated, Standards for Safety, UL 10B, Fire Tests of Door Assemblies.
15. ANSI in association with Door and Hardware Institute, ANSI/DHI A115.1, Preparation of Mortise Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames.
16. National Fire Protection Association, NFPA 80, Standard for Fire Doors and Fire Windows.
17. Door and Hardware Institute, DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
18. Door and Hardware Institute, DHI, Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.
19. Door and Hardware Institute, DHI, Sequencing and Format for the Hardware Schedule.
20. Steel Door Institute, SDI 109, Hardware for Standard Steel Doors and Frames.
21. Steel Door Institute, SDI 118, Basic Fire Door Requirements.
22. Underwriters Laboratories Incorporated, Standards for Safety, UL 305, Panic Hardware.
23. Underwriters Laboratories Incorporated, UL, Building Materials Directory.
24. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).
25. Hollow Metal Manufacturers Association, Division of National Association of Architectural Metal Manufacturers, HMMA 830, Hardware Preparation and Locations for Hollow Metal Doors and Frames.
26. The 2012 Phoenix Building Construction Code and adopted amendments.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:

1. Actual unit of each finish hardware item specified incorporating all standard and special features and finishes specified, demonstrated and identified by manufacturer's representative to ENGINEER. Samples shall be presented at time of Shop Drawing submittal, as ENGINEER will not review or approve Shop Drawings without concurrent sample submissions.
2. Approved samples may be incorporated into the finish hardware Work.
3. ENGINEER'S review will be for appearance and for general compliance with required features. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
1. Copies of manufacturer's data for each item of finish hardware. Include whatever information may be necessary to show compliance with specified requirements, and include instructions for installation and for maintenance of operating parts and exposed finishes. Include mounting heights and locations for each item of finish hardware. Provide ENGINEER with latest complete technical catalogue of all available finish hardware manufactured by proposed manufacturers, even if manufacturer specified by ENGINEER is submitted by CONTRACTOR to perform the Work. Furnish templates to fabricators of other work which is to receive finish hardware.
2. Copies of the Finish Hardware Schedule in the manner and format specified, complying with the actual construction Progress Schedule requirements (for each draft). Include explanation of abbreviations, symbols, and codes used to present scheduled information.
3. Based on the finish hardware requirements specified, organize the final Finish Hardware Schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other Work (such as hollow metal frames) which may be critical in the Project Schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with Shop Drawings for other Work, delivery schedules and similar information have been completed and accepted.
4. Finish Hardware Schedules are intended for coordination of the Work. Review and acceptance by ENGINEER does not relieve CONTRACTOR of responsibility to fulfill the requirements as shown and specified.
5. Operations and Maintenance Manuals:
   a. Submit complete installation, operation and maintenance manuals including: detailed procedure for routine maintenance and cleaning, detailed procedures for repairs such as dents, scratches and staining, detailed maintenance data and schedules, description of operation, spare parts information, and parts identification drawings and manual.
   b. Hardware schedule, including manufacturer, finish and model numbers shall be included in the Operations and Maintenance Manuals as outlined in paragraph 3.6.B below..

C. Test Reports: Submit for approval certified independent laboratory test reports for BHMA certification program and certification tests for each type of product specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver items of finish hardware sufficiently in advance of their setting for proper inspection. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.
   2. Deliver all items of finish hardware in manufacturer's original, undamaged packages, bearing accurate representation of the item within each package.
   3. Pack each piece of finish hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with items submitted on approved Shop Drawings and as specified.
   4. Inspect items upon delivery for damage. Items that arrive in damaged condition shall be permanently removed from the site and not offered again for approval by ENGINEER.

B. Storage and Handling of Materials:
   1. Provide secure storage area for finish hardware items, secured by locks and accessible only to finish hardware installer, ENGINEER and CONTRACTOR.
   2. Store finish hardware in manufacturers' original packages.
   3. Control the handling and installation of finish hardware items which are not immediately replaceable, so that the completion of the Work will not be delayed by finish hardware losses, both before and after installation.
   4. Comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

1.5 JOB CONDITIONS

A. Scheduling:
   1. Deliver individually packaged finish hardware items at the proper time to the proper locations for installation.
   2. Coordinate with other Work by furnishing Shop Drawings, inserts, templates and similar items at the appropriate times for proper sequencing of construction without delays.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. General:
   1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of finish hardware for proper installation and operation of the door swing as shown on the Drawings.
   2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with labels required by governing authorities.
   3. Base Metals: Produce finish hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
   4. Fasteners: Manufacture finish hardware to conform to published templates, generally prepared for machine screw installation. Do not provide finish

hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.

5. Furnish screws for installation, with each finish hardware item. Provide Phillips flat-head screws, except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.
7. Provide concealed fasteners for finish hardware units which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.
8. Tools for Maintenance: Furnish a complete set of specialized tools as required for OWNER'S continued adjustment, maintenance, removal and replacement of finish hardware.

B. Mortise Hinges:
   1. Templates and Screws: Provide only template-produced units.
   2. Base Metal: Except as otherwise specified, fabricate hinges from steel and finish to match the latch and lock set.
   3. Number of Hinges:
      a. Two Hinges: For doors with heights up to 60 inches (1524 mm).
      b. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
      c. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
      d. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).
   4. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
      a. Interior Doors:
         1) Average use, maximum 36-inches wide: 4-1/2-inch by 4 ½-inch standard weight (0.134-inches).
      b. Entrance, exterior, restroom, corridor and high frequency use Doors:
         1) Maximum 48-inches wide: 5-inch by 5-inch heavy weight (0.190-inch).
   5. Types of Hinges: Provide full-mortise type, antifriction-bearing hinges, swaged for mortise applications, inner leaf beveled, square cornered, unless manufacturer's recommendations indicate that half-mortise, half-surface, full-surface or other type should be used for the frame and door type or condition.
   6. Hinge Pins: Except as otherwise specified, provide hinge pins as follows:
      a. Pins: Steel.
      b. All Doors : Non-removable pins. Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
      c. Tips: Slope ends of hinge barrel.

7. ANSI/BHMA: A156.1 and A156.7.
8. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
9. Coordinate and provide manufacturer's recommended wires for electrified hinges. At a minimum 6-wire transfer hinges for bored locksets and mortise locksets, and 10-wire transfer hinges for panic exit devices.
10. Product and Manufacturer: Provide one of the following:
    a. T4A3786 and TA2714 by McKinney Products Company, an ASSA ABLOY Group Company
    b. Stanley Hinges, A Division of Stanley Security Solutions.
    c. Ives Hinges, Ives Architectural Products, an Allegion PLC Company.
    d. Hager Hinges, by Hager Companies.
    e. Or equal.

C. Bored Locks and Latch Sets:
1. Strikes: Provide 28-series lip strike, for each location and use shown. Provide stainless steel curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
2. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
3. Finish: US 26D satin.
4. BHMA: A156.2.
5. Coordinate and provide manufacturer's recommended wires for electrified hinges. At a minimum 6-wire transfer hinges for bored locksets.
6. Product and Manufacturer: Provide one of the following:
    a. Sargent Manufacturing Company, an ASSA ABLOY Group Company, 11 Line I/C core lever, series 64 construction cores, LL Series Lever and rose trim.
    b. Sargent Manufacturing Company, an ASSA ABLOY Group Company, RX286410G71LL 26D X 24 Volt DC.

D. High-Security Mortise Locks and Latch Sets:
1. Strikes: Provide manufacturer's standard wrought box strike, for each location and use shown. Provide stainless steel curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
2. Lock Throw: Provide minimum of 3/4-inch anti-friction latch bolt and 1-inch dead bolt throw. Comply with UL requirements for throw of latch bolts and deadbolts on fire-resistance-rated openings.
3. Materials: Provide the following features and materials:
    a. Latch Bolt: Two-piece; mechanical; anti-friction; stainless steel.
    b. Dead Bolt: One-piece; stainless steel with two enclosed hardened-steel roller armor pins.
    c. Case: Wrought steel, zinc dichromatized.
    d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5, Grade 1.
    e. Armor Front: 8-inches by 1-1/4-inches wide minimum; steel.
    f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick minimum; stainless steel, US 32D.
    g. Hubs: Sintered steel, copper infiltrated.

h. Lever with Stop Pin: Brass, plated to match stainless steel; with additional built-in stop to prevent over-torquing of lever.
i. All components shall be of marine quality, wherever possible.

4. Backset: 2-3/4-inches.
5. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
6. Finish: US 26D satin.
7. ANSI/BHMA: A156.13, Series 1000, Security Grade 1.
8. Coordinate and provide manufacturer's recommended wires for electrified hinges. At a minimum 6-wire transfer hinges for mortise locksets.
9. Product and Manufacturer: Provide one of the following:
   a. Sargent Manufacturing Company, an ASSA ABLOY Group Company 64-8200 Series LL Trim.
   b. Schlage Manufacturing Company; an Allegion PLC Company L-Series Mortise Lock, 17 Lever, B-rose with 64-42x26Dx106 L Cam.
10. Product and Manufacturer (Electrified): Provide one of the following:
    a. Sargent Manufacturing Company, an ASSA ABLOY Group Company RX64-8200 Series LL Trim.
    b. Schlage Manufacturing Company; an Allegion PLC Company RX L-Series Mortise Lock, 9080EU(24 volts) with 17 Lever, B-rose with 64-42x26Dx106 L Cam.

E. Panic Exit Devices:
1. Exit Doors: Where required by governing jurisdictions, provide panic exit devices, of the type required, including UL labels, if required by governing jurisdictions.
2. Fire Doors: Where shown on the Drawings or specified as a fire-resistance-rated door, provide units listed and labeled by UL, to comply with the fire-resistance-rating and size of door shown.
3. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
4. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
5. Provide the following features and materials:
   a. Latch Bolt: Two-piece; mechanical; anti-friction; stainless steel.
   b. Dead Bolt: One-piece; stainless steel with two enclosed hardened-steel roller armor pins.
   c. Case: Wrought steel, zinc dichromatized.
   d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A, Sargent Manufacturing Company; an ASSA ABLOY group Company, series 64 construction cores
   e. Armor Front: 8-inches by 1-1/4-inches wide minimum; steel.
   f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick minimum; stainless steel, US 32D.
   g. Hubs: Sintered steel, copper infiltrated.
   h. Vertical Rod Devices: not permitted unless required by code.

i. Concealed bolts: Minimum 1/2-inch diameter, stainless steel.

6. Backset: Provide minimum backset of 2-3/4-inches.
7. Finish: US 32D satin.
8. ANSI/BHMA: A156.3, Type 3 and Type 8, Grade 1; F08, entrance by lever, key locks or unlocks lever for entrances shown as accessible to people with disabilities as required by ADAAG; and F05, entrance by thumb piece, key locks or unlocks thumb piece.
9. Coordinate and provide manufacturer's recommended wires for electrified hinges. At a minimum 10-wire transfer hinges for panic exit devices.
10. Product and Manufacturer: Provide one of the following:
    a. Von Duprin Manufacturing Company; an Allegion PLC Company series 98/99 with 996L lever trim. Order 64-34 rim cylinder to go with device.
    b. Von Duprin Manufacturing Company; an Allegion PLC Company series 33/35 with 370L lever trim. Order 64-42 for mortise cylinder to go with device.
    c. Sargent Manufacturing Company; an ASSA ABLOY Group Company series 64-80, ETL trim.
    d. Or equal.
11. Product and Manufacturer (Electrified): Provide one of the following:
    a. Von Duprin Manufacturing Company; an Allegion PLC Company series RX98/99 with 996L lever trim, battery back-up and power supply, EPT-10. Order 64-34 rim cylinder to go with device.
    b. Von Duprin Manufacturing Company; an Allegion PLC Company series RX33/35 with 370L lever trim, battery back-up and power supply, EPT-10. Order 64-42 for mortise cylinder to go with device.
    c. Sargent Manufacturing Company; an ASSA ABLOY Group Company series 80, ETL trim, 24-volt DC, part 55, battery back-up and power supply.
    d. Or equal.

F. Removable Mullions:
1. Removable Mullion: Provide with each pair of double doors identified in the Finish Hardware Table in Part 3 of the specification.
2. Fire-Resistance: Provide removable mullions in accordance with UL 305 and NFPA 252 as required by the contract documents.
3. Finish: US 32D satin.
4. BHMA A156.3.
5. Product and Manufacturer: Provide one of the following:
    a. KR-4954 (standard) 64-42X112X26, KR-9954 (fire-rated) by Von Duprin Manufacturing Company; an Allegion PLC Company.
    b. 64-L980s (standard), 64-12-L980 (fire) by Sargent Manufacturing Company; an ASSA ABLOY group Company.
    c. Or equal.

G. Cylinders and Keying System:
1. Equip all locks with manufacturer's cylinders for Sargent Series 64-6300 interchangeable-core pin tumbler inserts. Furnish only temporary construction cores ("64") for the construction period, and remove these before Substantial Completion. Construction control keys and cores shall not be part of OWNER'S permanent keying system.

2. Permanent keys and cores shall be furnished by the Owner and coordinated with City of Phoenix, Public Works Department.
3. Cylinder Material: Brass, bronze or stainless steel.
4. Cylinder Features: 6-pin, high-security, removable core.

H. Overhead, Surface-Mounted, Door Closers:
1. Provide all doors, unless specially shown on the Drawings or specified as being provided with heavy-duty surface-mounted overhead door closers. Provide both active and inactive door leafs with closers.
2. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
3. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
4. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
5. Comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA 80. Modify closers specified, as required.
6. Provide hold open feature for all non-fire-resistant-rated doors, unless otherwise specified.
7. Provide long arm to allow door to swing 180° where long arm will eliminate floor mounted stops.
8. Provide closers with spring power adjustment feature capable of increasing spring power 15 percent minimum in all closer sizes.
9. Provide individual regulating valves for closing and latching speeds, and separate adjustable backcheck valve.
10. Provide delayed closing action feature on all door closers. Position valve at top of closure.
11. Provide the following materials and features:
    a. Full Metal Cover: Aluminum.
    b. Case: Cast iron.
    c. Arms: Plated to match full metal covers.
    d. Other Parts: Steel.
    e. Extreme temperature fluid.
    f. Security torx machine screws.
    g. Ten year warranty.
    h. Provide manufacturer's optional corrosion protection.
12. Finishes: US 26D satin chrome. Color coordinate all arms and other accessories.
13. Highly Corrosive Atmospheres: Provide all closers with specified manufacturer's optional corrosion protection.
14. ANSI/BHMA: A156.4, Grade 1.
15. Product and Manufacturer: Provide one of the following:
    a. Interior doors and exterior doors – 4040XP series with EDA arm by LCN Manufacturing Company; an Allegion PLC Company.
    b. 281 series with 25-P10 arm by Sargent Manufacturing Company; an ASSA ABLOY Group Company.
    c. Or equal.

I. Heavy-Duty, Concealed Overhead Holders and Stops:

1. Provide heavy-duty, concealed overhead holders and stops on all exterior and all interior doors,. Comply with UL and NFPA requirements for hold-open feature.
2. Provide the following features and materials:
   a. Shock Absorber Spring: Heavy tempered steel.
   b. Channel: Heavy gage brass.
   c. All other Parts: Stainless steel.
   d. Adjustment: Degree of hold-open and stop shall be adjustable after installation.
3. Finish: US 32D satin.
4. Coordinate placement of concealed overhead holder and stop with overhead closers.
5. ANSI/BHMA: A156.8, C51511.
6. Product and Manufacturer: Provide one of the following:
   a. Heavy-Duty 100H (ADJ) Series Concealed Holders and Stops by Glynn-Johnson Part, an Allegion PLC Company.
   b. Series 690 by Sargent; an ASSA ABLOY Group Company.
   c. Or equal.

J. Door Pulls, Push and Protection Armor:
   1. Door Pulls: Provide heavy-duty surface-mounted door pulls with pull plates where specified in List of Finish Hardware Items at end of Part 3.
      a. Door pulls shall be stainless steel US 32D and have 1-inch diameter 12-inch long handles which project 2-1/2-inches from pull plate surface.
      b. Pull plates shall be 4-inches by 16-inches, stainless steel US 32D; 0.050-inches thick.
      c. Provide all non-removable fasteners.
      d. Pulls shall be fastened to plates at factory.
      e. ANSI/BHMA: A156.6, J405; B3E.
      f. Product and Manufacturer: Provide one of the following:
         1) Rockwood, an ASSA ABLOY Group Company.
         2) Trimco.
         3) Ives Door Pulls, Ives Architectural Products, an Allegion PLC Company.
         4) Or equal.
   2. Push Plates:
      a. Provide 0.125-inch thick stainless steel plate with No. 4 finish.
      b. Size: 8-inches by 16-inches with beveled edges.
      c. ANSI/BHMA: A156.6, J304; B3E.
      d. Manufacturer: Provide one of the following:
         1) Rockwood, an ASSA ABLOY Group Company .
         2) Trimco.
         3) Ives Push Plates, Ives Architectural Products, an Allegion PLC Company.
         4) Or equal.
   3. Protection Armor:
      a. Provide one armor plate per leaf of each door scheduled to receive armor-plate protection.
      b. Provide 16-gage stainless steel with No. 4 finish 10-inches high by 2-inches less in width than width of door on the push side and 1-inch less than door width on pull side.

c. ANSI/BHMA: A156.6, J101; B3E.
d. Manufacturer: Provide one of the following:
    1) Rockwood, an ASSA ABLOY Group Company.
    2) Trimco.
    3) Ives Protection Armor, Ives Architectural Products, an Allegion PLC Company.
    4) Or equal.

K. Stripping and Seals:
1. Provide perimeter weather stripping at all exterior doors. Provide stripping and seals for interior doors where scheduled in List of Finish Hardware Items at end of Part 3.
2. Continuity of Stripping: Except as otherwise specified, stripping at each opening shall be continuous and without unnecessary interruptions at door corners and hardware.
3. Replaceable Seal Strips: Resilient or flexible seal strip of every unit shall be easily replaceable and readily available from stocks maintained by the manufacturer.
4. Provide bumper-type weather-stripping at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
    a. Housing: Extruded aluminum with dark bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
    b. Dimensions: 1-3/8-inches by 7/8-inches; stop-mounted.
    c. Seals: Closed-cell extruded silicone.
    d. ANSI/BHMA: A156.22, R3E264.
    e. Product and Manufacturer: Provide one of the following:
        1) No. 350DSPK and 2891 DPK (for parallel arms) by Pemko Manufacturing Company.
        2) National Guard Products, Incorporated.
5. Provide surface-mounted door-bottom sweep of manufacturer's standard design, as follows:
    a. Housing: Extruded aluminum, 0.062-inch thick, with mill aluminum finish.
    b. Seal: Nylon Brush (NB).
    c. Mounting: Surface.
    d. ANSI/BHMA: A156.22, R3E344.
    e. Product and Manufacturer: Provide one of the following:
        a) No. 18061DNB by Pemko Manufacturing Company.
        b) National Guard Products, Incorporated.
        c) Or equal.

L. Thresholds:
1. All exterior and interior doors shall be provided with thresholds. Where one or more mullions are specified, cut threshold to allow mullions to extend continuously for the entire opening.
2. Metal: Mill finish extruded bronze.
3. Surface Pattern: Fluted tread, manufacturer's standard.
4. Provide countersunk stainless steel screws and expansion shields.
5. Width: 5-inches wide and of length sufficient to span full width of rough openings; coped and scribed neatly at and around door frames.
6. Construction:

a. Single-piece, complying with manufacturer's recommendations.

7. Profile: Provide manufacturer's unit which conforms with the minimum size and profile requirements specified.
   a. Floor Drop: Except where no change in floor elevation is shown from one side of threshold to the other, provide profile that accommodates 1/2-inch drop in floor elevation, unless another dimension is shown on the Drawings.
8. Thickness: 1/2-inch minimum.
9. ANSI/BHMA: A156.21, J12100.
10. Product and Manufacturer: Provide one of the following:
    a. 171B by Pemko Manufacturing Company.
    b. National Guard Products, Incorporated.
    c. Or equal.

M. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2 (non-sag) Class A for use with thresholds.

N. Silencers:
1. Provide silencers for all door frames.
2. Provide pneumatic design that, once installed, forms an air pocket to reduce noise.
3. Provide minimum of three per strike side of door jambs.
4. ANSI/BHMA: A156.16, BHMA 6.5, L03011.
5. Product and Manufacturer: Provide one of the following:
   a. Trimco.
   b. Ives Silencers, Ives Architectural Products, an Allegion PLC Company.
   c. Or equal.

O. Wall and Floor Stops: Provide the following where scheduled in List of Finish Hardware Items at end of Part 3:
1. Dome-Type Floor Stops:
   a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
   b. Coordinate height of dome-type floor mounted doors stops with threshold condition and undercut of door.
   c. Finish: US 26D satin chrome.
   d. ANSI/BHMA: A156.16, L12161.
   e. Product and Manufacturer: Provide one of the following:
      1) Ives Architectural Products, an Allegion PLC Company.
      2) Rockwood, an ASSA ABLOY Group Company.
      3) Or equal.
2. Wall Stops:
   a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
   b. Convex rubber bumper.
   c. ANSI/BHMA: A156.16, L12101.
   d. Product and Manufacturer: Provide one of the following:
      1) Ives Architectural Products, an Allegion PLC Company.
      2) Rockwood, an ASSA ABLOY Group Company.
      3) Or equal.

2.2 HARDWARE FINISHES

A. Provide matching finishes for finish hardware units at each door or opening, to the greatest extent possible in compliance with ANSI/BHMA A156.18.

B. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of finish hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate to receive finish hardware, and the conditions under which the Work will be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the finish hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Templates: Furnish finish hardware templates to each fabricator of doors, frames and other Work to be factory-prepared for the installation of finish hardware. Check the Shop Drawings of such other Work, to confirm that adequate provisions are made for the proper installation of the finish hardware.

B. Prepare Work to receive finish hardware Work in compliance with ANSI/DHI A115.1.

3.3 INSTALLATION

A. Mount finish hardware units at heights recommended in, Door and Hardware Institute, “Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames” and “Recommended Locations for Builders’ Hardware for Custom Steel Doors and Frames", except as otherwise specified or required to comply with governing authorities having jurisdiction at the site, HMMA 830 and ADAAG requirements. Refer to and comply with the requirements of Section 08 11 13, Hollow Metal Doors and Frames, Section 08 31 00, Access Doors and Panels.

B. Install each finish hardware item in compliance with the manufacturer's instructions and recommendations and approved Shop Drawings. Wherever cutting and fitting is required to install finish hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

F. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.

G. Set thresholds in a bead of elastomeric sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant before sealant cures to a firm set.

3.4 FIELD QUALITY CONTROL

A. Provide a written field report, prepared by installer's architectural hardware consultant, identifying actual condition, location, manufacturer, and product designation for each item of finish hardware actually present on each door at the site, including whether finish hardware is adjusted and operating properly, compared with each item referenced to approved Shop Drawings and Contract requirements.

B. Installer's hardware consultant shall provide opinions to, and assist ENGINEER in determining, acceptability of installation as Work proceeds. All comments and discussions, conversations and meetings with ENGINEER shall be included in written field report for submission to ENGINEER for review and approval at completion of finish hardware installation.

C. As part of written field report to be submitted to ENGINEER for approval, recommend remedial actions for Work not in compliance with the Specifications. No payment for Work shall be made until remedial recommendations and actions have been approved by ENGINEER and incorporated into the Work.

3.5 ADJUSTMENT AND CLEANING

A. Adjust and check each operating item of finish hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

B. Final Adjustment: Where finish hardware installation is made more than one month prior to Substantial Completion, return to the Work during the week prior to acceptance or occupancy, and make a final check and adjustment of all finish hardware items in each space and area. Clean and relubricate operating items as necessary to restore proper function and finish of finish hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.

C. Provide manufacturer's authorized representative to instruct and train OWNER'S personnel in proper adjustment and maintenance of finish hardware during the final adjustment of finish hardware.

D. Finish hardware which is blemished or defective will be rejected even though it was set in place before defects were discovered. Remove and replace with new finish hardware. Repair all resultant damage to other Work.

E. Continued Maintenance Service: Approximately six months after the acceptance of finish hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer, shall return to the Project and re-adjust every item of hardware to restore proper function of doors and finish hardware. Consult with and instruct OWNER'S personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace finish hardware items which have deteriorated or failed due to faulty design, materials or installation of finish hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance or the finish hardware.

3.6 LIST OF FINISH HARDWARE ITEMS

A. Scheduled items for each door are generic and rely on information specified above. The listing of hardware functions and types provided are only a general guideline for the final Finish Hardware Schedule. Submit a Finish Hardware Schedule acceptable to all governing authorities having jurisdiction at the site.

B. Hardware Schedule: Provide the following finish hardware items:

+ + END OF SECTION + +

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SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Furnish all labor, materials, equipment and incidentals required to provide gypsum wallboard as shown on the Drawings and specified. The Work also includes:
      a. Providing openings in gypsum wallboard to accommodate the Work under this and other Sections and building into the formwork all items such as sleeves, anchor bolts, inserts and all other items to be embedded in gypsum wallboard for which placement is not specifically provided under other Section.
   2. The extent of the gypsum drywall systems is shown on the Drawings and in schedules; and is hereby defined to include wall, column and ceiling finish with gypsum wallboard manufactured for direct application of decorative finishes, including a joint treatment system known as drywall finishing and other drywall trim systems.
   3. The types of Work required include the following:
      a. Ceiling suspension systems
      b. Metal stud systems.
      c. Metal furring for gypsum wallboard work.
      d. Drywall system face-type gypsum wallboard work
      e. Gypsum backing wallboards for gypsum wallboard facing or other finish.
      f. Exterior ceiling/soffit gypsum wallboard work.
      g. Sound deadening wallboard.
      h. Trim and accessories which are installed prior to or concurrent with gypsum wallboard.
      i. Sound attenuation blankets in the drywall system.
      j. Joint reinforcement and finish treatment with compounds.
      k. Special treatment for the subsequent application of flexible wall coverings.
      l. Partial treatment for the restriction of air or smoke passage through joints.
      m. Special treatment for exterior gypsum drywall.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the gypsum wallboard.

1.2 QUALITY ASSURANCE

A. Manufacturer: Provide products as manufactured by one of the following:

   1. United States Gypsum Company.
   2. Gold Bond Building Products, Division of National Gypsum Co.

B. Requirements of Regulatory Agencies:

1. Wherever a fire-resistance classification is shown on the Drawings or scheduled on the Drawings which includes gypsum wallboard (4-hour, 3-hour and similar designations), provide components complying with the applicable requirements of materials and installation established by UL, and other governing authorities.
2. FM Compliance: Comply with Approval Guide, for applicable fire- resistant constructions.

C. Allowable Tolerances: 1/8-inch offsets between planes of wallboard faces, and 1/4-inch in 8 feet for plumb, level, warp and bow.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ANSI A42.4, Interior Lathing and Furring.
2. ASTM A 641, Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
3. ASTM C 36, Specification for Gypsum Wallboard.
4. ASTM C 208, Specification for Cellulosic Fiber Insulating Board.
5. ASTM C 442, Specification for Gypsum Backing Board, Gypsum Coreboard and Gypsum Shaftliner Board.
6. ASTM C 475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
7. ASTM C 514, Specification for Nails for the Application of Gypsum Board.
8. ASTM C 557, Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
9. ASTM C 630, Specification for Water-Resistant Gypsum Backing Board.
10. ASTM C 645, Specification for Non-Structural Steel Framing Members.
11. ASTM C 840, Specification for Application and Finishing of Gypsum Board.
12. ASTM C 1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
13. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
14. ASTM E 90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
15. ASTM E 119, Test Methods for Fire Tests of Building Construction and Materials.
16. Gypsum Association, GA-216, Application and Finishing of Gypsum Board.
17. UL, UL U8-22, Wallboard, Gypsum.
18. UL 40-U18, Fire Resistance Classification.
19. UL, Fire Resistance Index.
20. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of manufacturer's product specifications and installation instructions for each gypsum drywall system required, including other data as may be required to show compliance with these Specifications, including certification that all materials meet specified tests and standards.
2. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials to the Project site with manufacturer's labels intact and legible.
   2. Deliver fire-rated materials bearing testing agency label and required fire classification numbers.

B. Storage and Handling of Materials:
   1. Store materials inside under cover, stack flat, off floor.
   2. Stack wallboard so that long lengths are not over short lengths.
   3. Avoid overloading floor system.
   4. Store adhesives in dry area and provide protection against freezing at all times.
   5. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

1.5 JOB CONDITIONS

A. Environmental Requirements:
   1. Temperature: During cold weather, in areas receiving wallboard installation, maintain temperature range between 55°F to 70°F for 24 hours before, during and after gypsum wallboard and joint treatment application.
   2. Ventilation:
      a. Provide ventilation during and following adhesives and joint treatment applications.
      b. Use temporary air circulators in enclosed areas lacking natural ventilation.
      c. Under slow drying conditions, allow additional drying time between coats of joint treatment.
      d. Protect installed materials from drafts during hot, dry weather.

B. Protection: Protect adjacent surfaces against damage and stains.

PART 2 - PRODUCTS

2.1 METAL SUPPORT MATERIALS

A. Ceiling Support Materials:
   1. Main Runners: 1-1/2-inch steel channels, either cold-rolled at 0.475 pounds per foot or hot-rolled at 1.12 pounds per foot. Provide rust-inhibitive paint finish.
   2. Furring Members: Screw-type hat-shaped furring channels of 25-gage zinc-coated steel; comply with ASTM C 645.
      a. Where shown on the Drawings as "Resilient", provide manufacturer's special type designed to reduce sound transmission.
   3. Furring Members: Screw-type C-shaped studs of the depth indicated, of 25-gage zinc-coated steel; comply with ASTM C 645.
   4. Hanger Wire: Galvanized, soft-temper steel wire complying with ASTM A 641, Class 1 coating, prestretched; sized in accordance with ANSI A42.4, unless otherwise specified.
   5. Hanger Anchorages: Comply with ANSI A42.4 for concrete inserts, clips, bolts, screws and other devices applicable to the indicated method of structural

anchorage for ceiling hangers. Size devices for three times calculated load supported, except size direct-pull concrete inserts for five times calculated load.

6. Furring Anchorages: 16 gage galvanized wire ties, manufacturer's standard wire-type clips, bolts, nails or screws as recommended by furring manufacturer and complying with ANSI A42.4.

B. Wall/Partition Support Materials:
   1. Studs: Light gage screw-type C-shaped studs of the depth indicated 25-gage, unless otherwise specified, zinc-coated steel; comply with ASTM C 645.
      a. Depth of Section: 3-5/8 inches, except as otherwise shown on the Drawings or specified.
      b. Runners: Match studs; type recommended by stud manufacturer for floor and ceiling support of studs, and for vertical abutment of drywall work at other work.
      c. Stiffeners: 3/4-inch cold-rolled steel channels at 0.3 pounds per foot. Provide rust-inhibitive paint finish.
      d. Stud System Accessories: Provide stud manufacturer's standard clips, shoes, ties, reinforcements, fasteners and other accessories as needed for a complete stud system.
   2. Furring Members: Screw-type hat-shaped furring channels, of 25-gage zinc-coated steel; comply with ASTM C 645. Where furring is applied vertically, provide special-shaped units at external corners.
      a. Where shown on the Drawings as "Resilient", provide manufacturer's special type designed to reduce sound transmission.
      b. Fasteners: Type and size recommended by furring manufacturer for the substrate and application specified.

2.2 GYPSUM WALLBOARD PRODUCTS

A. Exposed Gypsum Wallboard: Comply with ASTM C 36 for exposed gypsum wallboard, hereby defined to include work indicated for painted finish and similar forms of decoration as well as unfinished work.
   1. Fire Rated Type: Provide Type X (fire-resistant) where shown on the Drawings and where required to achieve specified fire-resistance ratings.
   2. Insulating Type: Provide aluminum foil backing where drywall Work is specified as insulating
   3. Thickness: 1/2-inch, except where otherwise specified or shown on the Drawings.
   4. Thickness: 3/8-inch, except where otherwise specified or shown on the Drawings.
   5. Sheet Size: 4 feet wide by maximum length available, which will minimize the number of end joints in the Work.
   6. Long-Edge Profile: Standard taper.
   7. Long-Edge Profile: Standard taper plus special bevel or rounded edges designed to reduce beading and ridging of joint treatment.

B. Gypsum Backing Wallboard: Comply with ASTM C 442.
   1. Fire Rated Type: Provide Type X (fire-resistant) where shown on the Drawings and where required to achieve specified fire-resistance ratings.
   2. Insulating Type: Provide aluminum foil backing where drywall Work is specified as insulating type.

3. Water-Resistant Type: Comply with ASTM C 630.
   a. Tapered-Edge Profile: Where water-resistant type is specified to extend beyond the application of wall tile and receive a painted finish, provide standard taper long-edge profile.
4. Thickness: As specified to make-up the total thickness of wall finishes, and to comply with fire-resistance ratings. Comply with GA-216 if not otherwise specified or shown on the Drawings.
5. Thickness: 3/4-inch, except where otherwise specified.
6. Thickness: 1-inch, except where otherwise specified.
7. Thickness: 5/8-inch, except where otherwise specified.
8. Thickness: 1/2-inch, except where otherwise specified.
9. Thickness: 3/8-inch, except where otherwise specified.
10. Sheet Size: 4 feet by 8 feet or longer.

C. Sound Deadening Wallboard: ASTM C 208, Class A, medium density mineral fiber.
   1. Thickness: 1/4-inch.
   2. Sheet size: 4 feet by 4 feet, 4 feet by 8 feet, 4 feet by 10 feet and 4 feet by 12 feet.

2.3 JOINT TREATMENT MATERIALS

A. Joint Tapes: Plain or perforated complying with ASTM C 475.

B. Joint compound: ASTM C 475 ready-mixed type adhesive ready for application, type as indicated.
   1. Provide casein-type dry powder compound.
   2. Provide non-casein-type dry powder compound.
   3. Provide special chemical-hardening-type, slow setting or regular setting, dry powder bedding compound.
   4. Provide vinyl-based ready-mixed liquid compound.
      a. Provide single multiple-use compound, designed to be used for both bedding and topping.
      b. Provide two separate compounds, one for bedding and one for topping.
   5. Do not use joint compounds, which contain asbestos fiber.

2.4 TRIM ACCESSORIES

A. General: Provide manufacturer's standard trim accessories of types shown on the Drawings or specified for drywall Work, formed of galvanized steel unless otherwise specified, with either knurled and perforated or expanded flanges for screws, and beaded for concealment of flanges in joint compound. Provide corner beads, L-type edge trim-beads, U-type edge trim-beads, special L-kerf-type edge trim- beads, and one-piece control joint beads.
   1. Semi-Finishing Type: Manufacturer's standard trim units, which are not to be finished with joint compound (non-beaded).
   2. Plastic Edge Trim: Manufacturer's standard rigid or semi-rigid PVC moldings of the semi-finishing type, shaped to provide resilient contact of gypsum wallboard edges with other work; friction- fit, or pressure-sensitive adhesive mounting.

2.5 MISCELLANEOUS MATERIALS

A. Laminating Adhesive: The type and grade of adhesive or compound recommended by the gypsum wallboard manufacturer, for laminating gypsum wallboards together in applications as specified.

B. Fastening Adhesive: The type and grade of adhesive recommended by the gypsum wallboard manufacturer for fastening wallboard to structural supports or substrates as specified.
   1. On wood supports provide adhesive complying with ASTM C 557.

C. Gypsum Wallboard Fasteners: Comply with GA-216, and with gypsum wallboard manufacturer's recommendations; choice is installer's option where more than one type is recommended for application specified.
   1. Screws, self-drilling, self-tapping, bugle head, for use with power driven tool.
      a. Type S for wallboard to sheet metal.
      b. Type W for wallboard to wood.
      c. Type G for wallboard to wallboard.

D. Water-Resistant Sealant: Type recommended by gypsum wallboard manufacturer for sealing cut edges and holes in water-resistant gypsum wallboard.

E. Acoustical Sealant: Non-shrinking, non-migrating, non-staining sealant of either non-drying or permanently-elastic type, as recommended by the gypsum wallboard manufacturer.
   1. Where exposed to view, provide paintable type acoustical sealant either latex or acrylic based type, or acrylic-latex type.

F. Sound Attenuation Blankets: Semi-rigid, friction-fit, spun mineral fiber blanket without membrane covering; flame-spread, smoke and fuel ratings of less than 25, UL-723; type recommended by manufacturer for maximum sound attenuation; thicknesses as shown on the Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and the spaces to receive gypsum wallboard, and the conditions under which gypsum wallboard is to be installed; and shall notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

B. Check framing for accurate spacing and alignment.

C. Verify that spacing of installed framing does not exceed maximum allowable for thickness of wallboard to be used.

D. Verify that frames are set for thickness of wallboard to be used.

E. Protrusions of framing, twisted framing members, or unaligned members shall be repaired before installation of wallboard is started.

3.2 INSTALLATION OF METAL SUPPORT SYSTEMS

A. General: Comply with ANSI A42.4 as applicable to the type of substrate and wallboard support system specified; and comply with the Gypsum Association GA-203 for installation of furring members.
   1. Do not bridge building expansion joints with support system. Frame both sides of joints with furring and other support as shown.
   2. Screw furring members of wood framing as specified.

B. Ceiling Support Suspension Systems:
   1. Furnish concrete inserts, steel deck hanger clips, and similar devices to other trades for installation well in advance of time needed for coordination with other work.
   2. Furnish and install concrete inserts, steel deck hanger clips, and similar devices in coordination with other work. Refer to Paragraph 1.1.B herein for the requirements of coordination with others.
   3. Secure hanger wires to structural support by wire-tying directly to structure where possible; otherwise tie to inserts, clips or other anchorage devices or fasteners as specified. Wire-tie hanger wires to main runners.
   4. Space main runners four feet on centers and space hangers four feet along runners, except as otherwise shown.
   5. Level main runners to a tolerance of 1/4-inch in 12 feet, measured both lengthwise on each runner and transversely between parallel runners.
   6. Wire-tie or clip furring members to main runners and to other structural supports as shown.
   7. Space furring member 16 inches on centers, except as otherwise specified.
   8. Space furring members 24 inches on centers, except as otherwise specified.
   9. Install auxiliary framing at termination of drywall Work, and at openings for light fixtures and similar work, as required for support of both the drywall construction and other work indicated for support thereon. Refer to Paragraph 1.1.B. herein for the requirements of coordination with others.

C. Wall/Partition Support Systems:
   1. Install supplementary framing, blocking and bracing to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported on gypsum wallboard alone. Refer to Paragraph 1.1.B. herein for the requirements of coordination with others.
   2. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Comply with details as shown on the Drawings.
   3. Anchor ends of horizontal stiffeners where system abuts structural columns or walls.
   4. Install runner tracks at floors, ceilings and structural walls and columns where gypsum wallboard stud system abuts other work, except as otherwise shown on the Drawings.
   5. Extend partition stud system through acoustical ceilings and elsewhere, as shown on the Drawings, to the structural support or substrate above the ceiling.
   6. Terminate partition stud system at ceilings, except where shown on the Drawings to be extended to structural support or substrate above.

7. Space studs 16 inches on centers, except as otherwise specified.
8. Space studs 24 inches on centers, except as otherwise specified.
9. Fasten studs at ends of floor and ceiling runner tracks by installing a screw into both flanges at each end.
10. Install horizontal stiffeners in stud system; space 4 feet-6 inches on centers vertically; wire-tie at each intersection.
11. Secure jamb studs to frames of openings with screws, wire-ties or welds, either directly to frames or to special frame-support brackets; and install runner track sections, for jack studs above and below openings, secured to jamb studs.
    a. Space jack studs same as partition studs, and screw to runner tracks above and below.
    b. Install two studs at each jamb of each opening over 24-inches wide, except as otherwise specified.
    c. Install three studs at each jamb of each opening over 24-inches wide, except as otherwise shown.
    d. Install horizontal stiffeners 6-inches above and 6-inches below each opening more than 3 feet-0 inches wide, and extend two regular stud spaces beyond each jamb.
12. Space furring members 16 inches on centers, except as otherwise specified.
13. Space furring members 24 inches on centers, except as otherwise specified.
14. Install extra furring members and angle runners at terminations of drywall Work, and at openings and where required for support of other work occurring in the drywall Work.

3.3 INSTALLATION OF GYPSUM WALLBOARD

A. Preparations and Coordination:
   1. Pre-Installation Coordination: Prior to the start of installation of gypsum wallboard, coordinate work requiring openings, chases, frames, access panels, support and similar integrated requirements, including heating and ventilating and electrical work. Refer to Paragraph 1.1.B. herein for the requirements of coordination with others.
      a. Do not proceed with gypsum wallboard installation until blocking, framing, bracing and other supports for subsequently applied work have been installed.
      b. Do not install gypsum wallboard until thermal insulation to be concealed by wallboard has been installed.
      c. Install sound attenuation blankets where shown on the Drawings and where required to achieve STC ratings or fire-resistance ratings, before installation of gypsum wallboard, unless blankets can be readily installed after wallboard has been installed.

B. General Installation Requirements:
   1. Standards: Comply with GA-216, unless otherwise shown on the Drawings or specified. Comply with requirements for indicated fire- resistance ratings.
   2. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 12-inches in alternate courses of wallboard.
   3. Install exposed gypsum wallboard with face side out. Do not install imperfect damaged or damp wallboards. Butt wallboards together for a light contact at edges and ends with not more than 1/16-inch open space between wallboards. Do not force into place.

4. Locate either edge or end joints over supports, except in horizontal applications or where intermediate supports or gypsum wallboard back-blocking is provided behind end joints. Position wallboards so that both tapered edge joints abut, and mill-cut or field-cut end joints abut. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.
5. Attach gypsum wallboard to framing and blocking as required for additional support at openings and cutouts.
6. Cut back paper; do not tear or snap.
7. Form curved surfaces by carefully bending and fastening wallboard to a smooth even curve, free of flat or distorted areas and other imperfections. Comply with manufacturer's instructions for dampening of sheets or scoring of back face, if required to form to the radius shown on the Drawings.
8. Form control joints in wallboard construction where shown on the Drawings. Allow 1/2-inch continuous opening between edges of adjacent wallboards for insertion of control joint trim accessory.
9. Do not locate joints within 8-inches of corners or openings, except where control joints are shown on the Drawings at jamb lines or where openings occur adjacent to corners in the partition/wall layout. Where necessary, place a single vertical joint over the center of wide openings.
10. Install gypsum wallboard on both faces of steel stud partition framing above ceilings and in similar concealed spaces, except in chase walls, which are properly braced internally.
    a. Where partition in concealed spaces is not required for STC rating, fire-resistance rating, or control of air distribution, smoke or heat, studs may be faced with scraps of gypsum wallboard applied in a single layer. Apply each piece with two or more screws in each stud, 12-inch maximum screw spacing. Cover at least 75 percent of each face.
11. Provide perimeter isolation where non-load-bearing partitions abut structural decks or ceilings, or vertical structural elements. Allow not less than 1/4-inch, or more than 1/2-inch gap between gypsum and structure. Finish edges of face layer with J-type (semi-finishing) casing bead. Seal space between casing bead and structure with continuous acoustical sealant bead. Attach gypsum wallboard to studs not less than 1/2-inch below bottom edge of ceiling track flanges and to first stud adjacent to vertical tracks. Do not attach wallboard directly to tracks.
12. Where concrete columns are shown on the Drawings to be enclosed with drywall construction, provide freestanding vertical steel stud furring as required to support gypsum wallboard with not less than 1/2-inch clearance between concrete and furring, and between concrete and gypsum wallboard.
13. Floating Construction: Where feasible, and recommended by manufacturer, install gypsum wallboard with "floating" internal corner construction, unless isolation of the intersecting wallboards, or control or expansion joints are shown on the Drawings.

C. Sound-Rated Gypsum Wallboard:
    1. Sound-rated applications are defined to include the following types of construction:
        a. Single layer applications where sound transmission class (STC) is shown on the Drawings.

b. Multi-layer applications where two or more layers are applied to supporting structure including the following:
   1) Balanced partitions or walls with two or more layers applied to both faces of supports.
   2) Unbalanced partition or walls with one layer applied to one face and two layers applied to other face of supports.
c. Resilient furring applications of gypsum wallboard.

2. Seal perimeter of sound-rated work as follows:
   a. At partitions, provide continuous beads of acoustical sealant at juncture or both faces of runners of plates with floor and ceiling construction, and wherever work abuts dissimilar materials. Seal prior to installation of gypsum wallboards.
   b. At ceilings, provide continuous beads of acoustical sealant wherever Work abuts dissimilar materials.
   c. At control joints, provide continuous bead of sealant between edges of gypsum wallboards. Seal prior to installation of surface-applied control joint accessories and locate at proper depth in joint to allow for insertion of expansion portion of control joint accessory.
   d. Provide double seal at laminated partition faces. Install face layer with 1/4-inch edge clearance at terminations of work, and install continuous bead of acoustical sealant all around.
3. At openings and cutouts, fill open spaces between edges of gypsum wallboard and fixtures, cabinets, ducts and other flush or penetrating items, with continuous bead of acoustical sealant.
4. Seal sides and backs of electrical boxes to completely close up openings and joints with a bead of acoustical sealant.
5. Sound Flanking Paths: Where sound-rated partitions intersect non-rated or walls partitions extend sound-rated construction to completely close sound flanking paths through non-rated construction. Seal joints between face layers at vertical interior angles of intersecting partitions.
6. Ceiling Plenums: Where sound-rated partitions extend through non-sound rated ceilings to structural substrates above, extend the same treatment to that portion of the partition above the ceiling as specified for portion below the ceiling.
   a. For double-layer partition applications, install base layer only above ceilings.
7. Partition Insulation: Install sound attenuation blankets, in partitions where shown on the Drawings. Completely blanket space between studs to full height of partitions. Fit carefully behind electrical outlets and other work, which penetrates partitions. Attach to back face of gypsum wallboard in accordance with manufacturer's instructions.
8. Ceiling Insulation: Install sound attenuation blankets on gypsum wallboard in ceilings where shown on the Drawings. Completely blanket ceiling area, and lay over interrupting items where possible; abut penetrating work tightly.

D. Methods of Gypsum Wallboard Installation:
1. General: In addition to compliance with the standards, comply with the specific requirements indicated for each type or arrangement of gypsum wallboard system shown on the Drawings.
2. Single-Layer Ceilings: Apply exposed gypsum wallboard on ceilings, before applications on walls and partitions, to the greatest extent possible.

a. Apply in direction, which will minimize end joints.
b. Fasten with screws.
c. Fasten with adhesive and supplementary screws.
d. Acoustical Tile Base: Where gypsum wallboard ceiling is shown on the Drawings as base for adhesively-applied acoustical ceiling tile, install gypsum backing wallboard, with end joints staggered over supports.
e. For parallel applications, locate edge joints over supports; for right-angle applications, stagger end joints over supports.

3. Single-Layer Walls and Partitions: Install exposed gypsum wallboard in the manner indicated.
   a. Apply sheets vertically and provide sheet lengths, which will minimize end joints.
   b. Where height of work is less than 8 feet, sheets may be applied horizontally in maximum length available and used so as to minimize end joints.
   c. For parallel applications, locate edge joints over supports; for right-angle applications, stagger end joints over supports.
   d. Fasten with screws, or with nails where permitted by ENGINEER.
   e. Fasten with adhesive, and supplement with nails or screws.
      1) At sliding-door pockets, fasten with adhesive and provide temporary bracing or fasteners.
   f. At showers and similar "wet" areas indicated for tile finish, install water-resistant backing wallboard. Apply horizontally with uncut edge at bottom of work, 1/4-inch above fixture lip. Seal cut edges of each piece with water-resistant sealant before installation and seal around pipe penetrations and similar cut-outs in each sheet.
4. Double-Layer Ceilings: Install base layer of gypsum backing wallboard or exposed type gypsum wallboard, at installer's option, and then face layer of exposed gypsum wallboard. Apply base layer before applications on walls and partitions, to the greatest extent possible, and apply at right-angles to support with end joints staggered over supports.
   a. Laminate face layer to base layer with laminating adhesive. Apply in direction which results in minimum end joints, and offset joints (both directions) with base layer joints at least 10-inches.
      1) Brace or temporarily fasten face layer until adhesive has dried.
      2) Supplement adhesive with permanent screw fastening of face layer, through base layer and into supports.
   b. Where resilient furring members are shown on the Drawings between base and face layers, install furring at right-angles to supports, and lay face layer at right-angles to furring with end joints staggered over furring members. Screw furring to supports through base layer, and screw face layer to furring members.
5. Double-Layer Walls and Partitions: Install base layer of gypsum backing wallboard or exposed type gypsum wallboard, at installer's option, and face layer of exposed gypsum wallboard. Apply both layers vertically; with joints of base layer over supports and joints of face layer offset at least 10-inches with base layer joints. Provide sheet lengths, which will minimize end joints in face layer.
   a. Fasten base layer with screws.
   b. Fasten face layer with screws through base layer and into supports.
   c. Laminate face layer to base layer with laminating adhesive.
      1) Brace or temporarily fasten face layer until adhesive has dried.

2) Supplement adhesive with permanent screw fastening of face layer through base layer and into supports.

6. Direct-Bonding to Substrate: Where gypsum wallboard is shown on the Drawings to be directly adhered to a substrate, other than studs, joists, furring members or base layer of gypsum wallboard, comply with gypsum wallboard manufacturer's recommendations, and temporarily brace or fasten gypsum wallboard until fastening adhesive has set.

3.4 INSTALLATION OF DRYWALL TRIM ACCESSORIES

A. General: Coordinate, and integrate where possible, the installation of trim accessories with the installation of gypsum wallboard. Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum wallboard to the supports. Otherwise, fasten flanges by screws in accordance with manufacturer's instructions.

B. Install metal corner beads at external corners of drywall Work.

C. Install metal edge trim wherever edge of gypsum wallboard would otherwise be exposed or semi-exposed.
   1. Install L-type trim-beads, for joint compound, where edge is shown on the Drawings to be tightly fitted to abutting work, without reveal or sealant pocket.
   2. Install U-type trim-beads, for joint compound, where edge is not tightly fitted to abutting work, exposed, revealed with a sealant pocket, gasketed, or with other separation, except as otherwise indicated.
      a. Install special kerf-type I-trim where adjoining work is kerfed to receive leg of trim unit.
   3. Install J-type semi-finishing trim, not for joint compound, at the following locations and elsewhere as shown on the Drawings:
      a. Edges of exterior gypsum wallboard not covered by applied moldings.
      b. On interior wall panels of exterior walls at the juncture with ceilings.
      c. At sealant-filled isolation joints and sound control joints, where gypsum drywall work abuts other construction including walls and ceilings.
      d. At sealant-filled or gasket-filled building expansion joints; install back-to-back units spaced as shown on the Drawings, 1/4-inch if not otherwise shown.

D. Install plastic edge trim where shown on the Drawings on wall panels at juncture with ceilings.

E. Install control joint bead units where control joints are shown on the Drawings.

F. Install H-Molding in exterior gypsum drywall work where control joints are shown on the Drawings. Do not exceed spacing recommended by gypsum wallboard manufacturer.

G. Miter corners of exposed molding and trim (semi-finishing) units. Align joints and support to eliminate offsets.

3.5 FINISHING

A. General: Comply with manufacturer's instructions for the mixing, handling and application of materials. Machine or hand application is installer's option. Apply treatment at joints both directions, flanges of trim accessories, but not semi-finishing types, penetrations of the gypsum wallboard, electrical boxes, piping and similar work, fastener heads, surface defects and elsewhere as shown on the Drawings or specified. Apply in the manner, which will result in each of these being concealed when applied decoration has been completed.
   1. Where open joints of more than 1/16-inch occur, including edges of wallboards with rounded or beveled corners, prefill joint with special chemical-hardening-type bedding compound, prior to bedding of joint tape.
   2. Apply joint tape at joints between gypsum wallboards, except where a trim accessory is shown on the Drawings.
   3. Do not use topping compound for bedding the joint tape.
   4. Apply joint compound in three coats, not including prefill or openings in base, and sand between last two coats and after last coat.
   5. Do not use bedding compound for the final coat of joint treatment, unless specifically recommended by the manufacturer for that use and approved by ENGINEER.

B. Install metal corner tape in lieu of joint tape at external corners.

C. Install metal corner tape in lieu of joint tape at diagonal and non-right-angle internal corners in the Work, and elsewhere as shown on the Drawings.

D. Install plastic edge trim at juncture of walls and partitions with ceilings, and elsewhere as shown on the Drawings. Install after completion of joint treatment.

E. Base for Acoustical Tile: Where gypsum wallboard is shown on the Drawings as a base for adhesively-applied acoustical tile, install tape and 2-coat compound treatment, without sanding.

F. Base for Tile: Where gypsum wallboard is shown on the Drawings as a base for thin-set ceramic tile finish, and similar rigid applied finishes, do not install drywall finishing in the area to receive the applied finish.

G. Base for Flexible Wall Coverings: Where gypsum drywall is shown on the Drawings as a base for the adhesive-application of flexible wall coverings, comply with manufacturer's instructions for applying joint compound and joint tape in minimum thicknesses over end-joints and cut- joints, so as to avoid a build-up of tape and compound which would telegraph through. Select topping coat for maximum strength and bond with gypsum wallboard.

H. Partial Finishing: Omit drywall finishing only where specifically shown on the Drawings as unfinished. Omit third topping coat of compound and omit sanding where shown for partial finish and where Work is concealed, including partition/wall/ceiling surfaces above suspended ceilings where Work is shown on the Drawings or specified for fire-resistance, smoke barrier, sound attenuation, air plenum or similar purposes.

I. Consult specified manufacturer's product literature.

3.6 ADJUSTING AND CLEANING

A. Ridging:
   1. Do not repair ridging until condition has fully developed: approximately six months after installation or one heating season.
   2. Sand ridges to reinforcing tape without cutting through tape.
   3. Fill concave areas on both sides of ridge with topping compound.
   4. After fill is dry, blend in topping compound over repaired area. Fill cracks with compound and finish smooth and flush.
   5. Installer shall advise CONTRACTOR and ENGINEER of required procedures for the protection of completed drywall finishing from damage and deterioration during the remainder of the construction period. Provide required protection.

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SECTION 09 51 00

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install acoustical panel ceilings. The Work also includes:
      a. Providing openings in acoustical panel ceilings to accommodate the Work under this Section and other Sections and building into the acoustical panel ceilings all items to be embedded in, or penetrate, acoustical panel ceilings.
   2. Extent of acoustical panel ceilings is shown on the Drawings.
   3. Types of products include the following:
      a. Non-directionally textured, ceramic, acoustical panel ceiling tiles.
      b. Intermediate-duty, exposed acoustical panel suspension system.
      c. Acoustical sealants.
      d. Miscellaneous fasteners, clips, hangers, tie-wire and other accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the acoustical panel ceilings.
   2. Coordinate furnishing and installing products for maintaining the fire-resistance-rating of ceiling construction at perimeters and penetrations where built-in and recessed items and transitions with other building components occur in the Work.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single installer regularly performing installation of acoustical panel ceilings with documented skill and successful experience in the installation of the types of materials required; and who agrees to employee only tradesmen who are trained, skilled and have successful experience in installing the types of materials specified.
   2. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owners, architects or engineers responsible for projects.
      b. Approximate contract cost of the acoustical panel ceilings.
      c. Amount of area installed.

B. Testing Agency Qualifications: To qualify for approval, an independent testing agency shall demonstrate to ENGINEER'S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

C. Performance Criteria:
   1. Standards for Terminology and Performance: Applicable publications by the Ceiling and Interior Systems Construction Association (CISCA), including "Ceiling Systems Handbook" and ASTM C 635.
   2. Provide individual ceiling products in compliance with ASTM E 1264.
   3. Light Reflectance Ratings: Except as otherwise shown on the Drawings or specified, provide factory-finished acoustical panels that have been tested in compliance with ASTM E 1477 by a recognized testing laboratory, to show a light reflectance rating of not less than the following:
      a. Light Reflectance: Not less than 0.75.
   4. Fire-Test-Response Characteristics of Acoustical Panels: Provide acoustical panels with surface-burning characteristics complying with ASTM E 1264 for Class A materials on face side; as determined by testing identical products in compliance with ASTM E 84.

D. Requirements of Regulatory Agencies:
   1. Wherever a fire-resistance-rated construction assembly classification is shown on the Drawings or scheduled that includes acoustical panel ceiling assemblies (2-hour, 1-hour and similar designations), provide components complying with the applicable requirements for materials and installation established by UL, and other governing authorities having jurisdiction.
   2. UL Compliance: Comply with UL's "Fire Resistance Directory", for applicable fire-resistant construction systems.
   3. Size anchorage devices for ceiling hangers for three times supported load, except size direct-pull concrete inserts for five times supported load, for structural classification specified, complying with ASTM C 635, Table 1, Direct Hung, unless more stringent requirements are specified by governing authorities having jurisdiction and in compliance with ASTM E 488.
   4. Attachment Devices: Size internal attachment devices within suspended ceiling system for five times the design load indicated in ASTM C 635, Table 1, Direct Hung.

E. Source Quality Control:
   1. Furnish all components of each acoustical panel ceiling system from a single manufacturer and from a single supplier with adequate resources to provide products of consistent performance characteristics, physical properties and appearance, without delaying the Work.

F. Allowable Tolerances:
   1. Surfaces to receive acoustical treatment: Free from irregularities and level to within 1/4-inch in 12 feet-0 inches.
   2. Deflection:
      a. Suspension system components, hangers, and fastening devices supporting light fixtures, ceiling grilles, and acoustical units: Maximum deflection 1/360 of the span.
      b. Deflection Test: ASTM C 635.
   3. Allowable Tolerance of Finished Acoustical Ceiling System: Level within 1/8-inch in 12 feet-0 inches.
   4. Accessibility Percentage: 100.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   2. ASTM A 366, Specification for Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold-Rolled.
   3. ASTM A 510, Specification for General Requirements for Wire Rods and Coarse Round Wire,
   4. ASTM A 641, Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   5. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   6. ASTM C 423, Test method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   7. ASTM C 635, Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
   8. ASTM C 636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
   9. ASTM C 834, Specification for Latex Sealants.
   10. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   11. ASTM E 119, Test Methods for Fire Tests of Building Construction and Materials.
   12. ASTM E 413, Classification for Rating Sound Insulation.
   13. ASTM E 488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   14. ASTM E 580, Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint.
   15. ASTM E 795, Practices for Mounting Test Specimens During Sound Absorption Tests.
   16. ASTM E 1264, Classification for Acoustical Ceiling Products.
   17. ASTM E 1414, Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
   18. ASTM E 1477, Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
   19. ASTM F 593, Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
   20. ASTM F 594, Specification for Stainless Steel Nuts.
   21. Ceiling and Interior Systems Construction Association, CISCA, Ceiling Systems Handbook.
   22. Architectural Metal Products Division of The National Association of Architectural Metal Manufacturers, AMP 501, Finishes for Aluminum.
   23. Ceiling and Interior Systems Construction Association, CISCA, Acoustical Ceilings: Use and Practice.
   24. Underwriters Laboratories Incorporated, UL, Fire Resistance Directory.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Full size samples for each acoustical panel specified. Samples shall show the full range of exposed color and texture to be expected in the completed Work.
   2. 12-inch long samples of each exposed runner and molding.

3. ENGINEER'S review will be for color and texture only. Compliance with other requirements is the responsibility of CONTRACTOR.
4. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

B. Shop Drawings: Submit for approval the following:
1. Qualification data for firms, as specified in Article 1.2, above.
2. Copies of manufacturer's product specifications and installation instructions for each acoustical ceiling material required, and for each suspension system. Include certified laboratory test reports and other data as required to show compliance with these Specifications.
a. Include manufacturer's recommendations for cleaning and refinishing acoustical units, including precautions against materials and methods which may be detrimental to finishes and acoustical performances.
3. Reflected ceiling plans of suspension systems, showing hanger, anchor and acoustical panel locations, drawn to a scale of 1/4-inch equal to 1 foot-0 inch, and details of all transitions of acoustical panels with other items such as light fixtures, air diffusers, and perimeter walls and all supporting and suspension system details, including method of attachment of suspension system hangers to building structure, drawn to a scale of 3/4-inches equal to 1 foot-0 inches.
4. Show and coordinate locations of ceiling-mounted items, automatic fire suppression system sprinkler heads, speakers, and penetrations for other items of Work that are to be coordinated with the ceiling, and show framing and support details for Work supported by the suspension system.
5. Complete information on all anchors and supports indicating maximum resistance to tension, in compliance with performance criteria specified.
6. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

C. Test Reports: Submit for approval the following:
1. Certify compliance with ASTM C 635 and other specified requirements, and indicate structural classification of each type of suspension system.
2. Evidence of acoustical panel ceiling system’s compliance with requirements of governing authorities having jurisdiction.
3. Certified field quality control test reports for required anchor performance tests.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver approved materials in original, unopened, undamaged, protective packaging, with manufacturer's and testing and inspection agencies labels accurately indicating brand name, pattern, size, thickness and fire-resistance-rating of packaged materials.
2. All markings and labels shall be legible and intact.
3. Inspect acoustical panel ceiling materials and reject components differing from approved Samples and Shop Drawings. Immediately remove rejected components from the site and do not incorporate into the Work.
4. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage and Handling of Materials:

1. Store materials in a fully enclosed space where they will be protected against damage and constantly within limits of manufacturer's written recommended environmental conditions.
2. Store materials in original protective packaging to prevent soiling, physical damage or wetting.
3. Store cartons open at each end to stabilize moisture content and temperature.
4. Handle materials in a manner that avoids chipping edges or damaging units in any way and as recommended by manufacturer's approved installation recommendations and the recommendations of specified standards.
5. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

1.5 JOB CONDITIONS

A. Environmental Requirements:
   1. Before installing acoustical panels permit them to reach room temperature and stabilized moisture content.
   2. Do not install interior acoustical panel ceilings until space has been enclosed and is weathertight, and until installation of moisture-bearing material in the space has been completed and the space is nominally dry, and until ambient conditions of temperature and humidity are continuously maintained at levels indicated for final occupancy.

B. Scheduling:
   1. Do not begin installation of acoustical panel ceilings until all Work above ceilings has been completed and accepted by ENGINEER.
   2. Furnish cast-in-place, and built-in-place anchors and their locations, to other trades for installation well in advance of time needed for coordinating locations of acoustical panel ceiling supports with other Work that must share plenum area above acoustical panel ceilings.

1.6 MAINTENANCE

A. Extra Materials:
   1. At time of completing the installation, deliver stock of extra material and store in a secure area at the site as directed by OWNER. Furnish full-size units, packaged with protective covering for storage, and identified with appropriate labels.
   2. Acoustical Panels: Furnish an amount equal to two percent of the amount installed, or at least one full package of acoustical panels.
   3. Do not provide partial packages of materials. Round-up quantities to furnish only complete, unopened and undamaged packages; with legible labels accurately representing contents of package indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
   4. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used on this Project, with calculations establishing quantity of extra materials to be furnished to OWNER.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. General:
      a. Standards: Provide manufacturer's standard acoustical panel ceiling systems that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light deflections.
      b. References: In general, the recommendations of CISCA, "Acoustical Ceilings: Use and Practice" shall be considered part of this Section, unless otherwise specified.
   2. Noise Reduction Coefficient (NRC): The average of sound absorption coefficients when tested in accordance with ASTM C 423 for a specification range of 10 points, for middle frequencies of 250, 500, 1,000, and 2,000 Hertz with face of test specimen mounted in compliance with ASTM C 795 for Mounting Type E-400 (400 millimeter air space) standard mounting according to ASTM E 1264. Provide not less than the following:
      a. NRC Rating: Range of 0.50, except as otherwise specified.
   3. Ceiling Attenuation Class: Provide acoustical panel ceilings that have been tested for sound transmission loss through the acoustical tile ceiling, determined in accordance with ASTM E 1414 and ASTM E 413. Provide not less than the following:
      a. CAC Class: 40, for mounting E-400.

2.2 CEILING PANELS

A. General: Unless otherwise specified, provide standard lay-in panels of the type selected by ENGINEER. Provide sizes shown on reflected ceiling plans or, if not otherwise shown, 24-inch by 24-inch grid-size panels.

B. Acoustical Panels:
   1. Environmental Profile:
      a. Acoustical panels shall contain neither man-made fibers, natural mineral fibers nor inorganic binders.
      b. Provide units that do not require the use of additives, surfacers or polyvinyl chloride facers to resist the growth of bacteria or fungus and that are unaffected by water or high humidity.
      c. Provide units that do not rely on the use of sealers to exclude particulate emissions off-gassing from acoustical ceiling panels.
      d. 100 percent recyclable.
   2. Acoustical Panels: Provide units manufactured from expanded volcanic clay and an inorganic binder fired at 960°F, not less than 7/8-inch thick, weighing 1.6 pounds per square foot. Provide a medium-coarse non-directional texture, fine line edge; chalk white color integral throughout; ASTM E 1264, Type XX.
   3. Physical Properties: Provide the following:
      a. Flame Spread, ASTM E 84: 0.
      b. Smoke Development, ASTM E 84: 0.
      c. Fuel Contribution, ASTM E 84: 0.
   4. Complete selection of manufacturer's standard and custom panel face profiles, patterns and textures for final selection by ENGINEER.

5. Product and Manufacturer: Provide one of the following:
   a. All-Environment Eurostone Sculptured Profile Ceiling Panels by Chicago Metallic Corporation.
   b. Or equal.

2.3 CEILING SUSPENSION SYSTEMS

A. General: Comply with ASTM C 635, as applicable to the type of suspension system required for the type of acoustical panel ceiling units specified.
   1. Structural Class, Intermediate-Duty System (Direct Hung): 12.0 minimum to 15.9 maximum, pounds per linear foot of main runners.
      a. Main Runners: 0.015-inch thick metal, minimum.
      b. Cross Tees: 0.015-inch thick metal, minimum.
   2. Structural Class, Heavy-Duty System (Direct Hung): 16 pounds per linear foot of main runners, minimum.
      a. Main Runners: 0.020-inch thick metal, minimum.
      b. Cross Tees: 0.020-inch thick metal, minimum.

B. Exposed Suspension System: Manufacturer's standard, 5/16-inch wide by 1-1/2-inch high exposed runners, cross-runners and accessories, with exposed cross runners stepped to lay flush with main runners; manufactured from hot-dipped galvanized G90, commercial steel CS Type B, complying with ASTM A 653; double-webbed construction with stainless steel clip end tap feature interlocking with cross tee slots to prevent lateral pull-out.
   1. Finish of Exposed Members: Provide uniform factory-applied finish on exposed surfaces of ceiling suspension system including moldings, trim and accessories.
   2. Finish of Exposed Members: Provide aluminum-capped components for all exposed cross tee and main tee faces.
      a. Finish: Manufacturer's standard baked enamel finish, white, unless otherwise selected by ENGINEER.
      b. Finish: Natural color anodized aluminum, 0.4-mil coating; NAAMM AA-C22A31.

C. Product and Manufacturer: Provide one of the following:
   1. 1200 System and Fire Front 1250 Direct Hung Suspension Systems by Chicago Metallic Corporation.
   2. Or equal.

2.4 MISCELLANEOUS MATERIALS

A. Hangers:
   1. Wire Hangers: Galvanized, soft-temper steel wire complying with ASTM A 641, Class C zinc coating, prestretched; bare steel diameter of 8-gage (0.162-inch).
   2. Rod Hangers: Commercial steel complying with ASTM A 510, mild carbon steel; 1/4-inch bare steel rod diameter; hot-dip galvanized in compliance with ASTM A 153, Class B-1.

3. Flat Hangers: Commercial steel sheet complying with ASTM A 366; bare steel size of 1-inch by 3/16-inches, minimum, and of lengths shown; hot-dip galvanized in compliance with ASTM A 153, Class B-1.
4. Angle Hangers: 2-inch by 2-inch by 1/4-inch, bare steel size, minimum; hot-dip galvanized in compliance with ASTM A 153, Class B-1.
5. Anchors:
   a. Provide anchors fabricated from stainless steel components complying with ASTM F 593 and ASTM F 594, Group 1, alloy Type 316 for bolts, and anchors with holes or loops for attaching hangers.
   b. Comply with ASTM E 488 for concrete inserts, clips, bolts, screws and other devices applicable to the indicated method of structural anchorage for acoustical panel ceiling hangers.

B. Hold-Down Clips for Non-Fire-Resistance-Rated Ceilings: For interior ceilings consisting of acoustical panels weighing less than one pound per square foot, provide hold-down clips spaced 2 foot-0 inches on centers on all cross tees.

C. Impact Clips: Where required, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

D. Sheet Metal Edge Molding and Trim: Type and profile shown on the Drawings, or if not shown, manufacturer's standard metal channel molding for edges and penetrations that fit acoustical panel edge details and suspension systems specified; formed from commercial grade sheet steel of same material, color and finish as used for exposed flanges of suspension system members.
   1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
   2. For circular penetrations in ceiling, provide shop-fabricated edge moldings fabricated to diameter required to fit penetrations exactly.
   3. For narrow-face suspension systems, provide suspension system and manufacturer's standard edge moldings that match width and configuration of exposed runners.

E. Extruded Aluminum Edge Molding and Trim: Type and profile shown on the Drawings, or if not shown, manufacturer's standard extruded aluminum molding for edges and penetrations that fit acoustical panel edge details and suspension systems specified; including splice plates, corner pieces, and attachment and other clips, complying with the following:
   1. Aluminum Alloy: 6063-T5 complying with ASTM B 221.
   2. Finish of Exposed Members: Provide the following finish for all edge moldings and trim components:
      a. Finish: Manufacturer's standard baked enamel finish, white, unless otherwise selected by ENGINEER.
      b. Finish: Natural color anodized aluminum, 0.4-mil coating; NAAMM AA-C22A31 complying with AMP 501.

F. Acoustical Sealant for Exposed and Concealed Joints: Provide a modified acrylic-latex, non-sag, paint able, non-staining, sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints in building

construction as demonstrated by testing representative assemblies according to ASTM E 90 and acceptable for use with UL Design Designations specified.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the acoustical panel ceiling Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Concrete Inserts: Provide inserts for incorporation into formwork. Furnish layouts for cast-in-place ceiling support anchors whose installation is specified in other Sections.

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid the use of less-than-half width panels at borders, and comply with approved Shop Drawing layout.

3.3 INSTALLATION

A. General:
   1. As a minimum standard, unless otherwise shown on the Drawings, specified, required by approved Shop Drawings, or governing authorities having jurisdiction, install acoustical panel ceilings to comply with CISCA's "Ceiling System Handbook".
   2. Where acoustical panel ceilings must resist lateral forces, comply with requirements of governing authorities having jurisdiction and ASTM E 580.

B. Install suspension systems to comply with ASTM C 636, with hangers supported only from building structural members. Locate hangers near each end and spaced four feet along each carrying channel or direct-hung runners, unless otherwise shown on the Drawings.
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.
   2. Splay hangers only where required and, if permitted by governing authorities having jurisdiction for fire-resistance-rated construction assemblies, to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other obstructions within ceiling plenum produces hanger spacing that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by reference standards and publications.

4. Secure wire hangers to ceiling suspension members by looping or wire-tying with a minimum of three tight turns, either directly to structure or to inserts, eyescrews, clips or other anchorage devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Connect hangers directly to structural members, including additional framing members introduced for ceiling support, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause hangers to deteriorate or otherwise fail due to age, corrosion or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Do not connect or suspend steel framing from ducts, pipes or conduit.
10. Sway-brace suspended steel framing with hangers used for support.
11. Space hangers not more than 4 foot-0 inches on centers along each member, supported directly form hangers and provide hangers not more than 8-inches from ends of each member.
12. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from structural members as required for hangers, without attaching top permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.
13. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

C. Arrange acoustical panels and orient directionally-patterned panels in the manner shown on approved Shop Drawings.
   1. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members.
   2. Install acoustical panels with pattern running in one direction.
   3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
   4. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings.
   5. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   6. Install hold-down clips for each panel, spaced as recommended by acoustical panel manufacturer for the application specified, except do not exceed spacing required by governing authorities having jurisdiction, or for fire-resistance-ratings.
   7. Install hold-down clips in areas shown on the Drawings, and in areas where required by governing authorities having jurisdiction, or for fire-resistance-ratings; space as recommended by panel manufacturer, unless otherwise specified.

D. Install edge moldings and trim of the type shown at edges of each acoustical ceiling area, and at locations where edge of units would otherwise be exposed after completion of the Work.

1. Sealant Bed: Apply acoustical sealant in a continuous ribbon, concealed on back of vertical legs of molding before fastening to vertical surface.
2. Secure moldings to building construction by fastening with screw-anchors into the substrate, through holes drilled in vertical leg. Space holes not more than 3- inches from each end and not more than 16 inches on centers along each molding, leveling with ceiling suspension system to tolerances specified.
3. Miter corners of moldings accurately to provide hair-line joints, securely connected to prevent dislocation.
4. Do not use exposed fasteners, including blind rivets, on molding or trim.

E. Install sound attenuation insulation in areas shown on the Drawings. Lay insulation directly on ceiling system, and close major openings to completely cover all areas shown to receive sound attenuation insulation.

3.4 FIELD QUALITY CONTROL

A. Engage the services of a qualified independent testing agency, approved by ENGINEER, for performing quality control testing.
B. Perform all specified testing in compliance with the requirements of ASTM E 488.

C. Extent and Testing Frequency: Testing shall take place in successive stages in areas described below. Proceed with installation of acoustical panel ceilings only after results for previously installed hangers comply with requirements.

D. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion, but no acoustical panels have been installed, perform the following tests:
1. Within each test area testing agency will select one of every ten anchors used to attach hangers to concrete and will test them for 1,140 pounds of tension. It will also select one of every two post installed anchors used to attach bracing wires to concrete and will test them for 1,620 pounds of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until twenty consecutively pass and then will resume initial testing frequency.

E. Testing agency shall report test results promptly and in writing to ENGINEER.

F. Where fasteners and anchors are removed and replaced, additional testing shall be performed to determine compliance with specified requirements.

3.5 ADJUSTMENT AND CLEANING

A. Do not proceed with installation of acoustical panels until testing is completed and non-complying fasteners and anchors have been replaced with new material complying with the requirements of the Specifications.

B. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings and suspension system members. Comply with manufacturer's written instructions for cleaning and touch-up of minor finish damage. Remove and replace Work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

C. Installer shall advise CONTRACTOR and ENGINEER of required protection for the acoustical panel ceilings, including manufacturer's recommended temperature and humidity limitations and dust control, so that the Work will be without damage and deterioration at the time of acceptance by OWNER. Provide required protection.

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SECTION 09 61 11

CONCRETE HARDENER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all concrete hardener Work.
   2. The extent of the concrete hardener includes all interior concrete floors not shown on the Drawings or scheduled to be finished with another material.
   3. The types of concrete hardener Work required includes, but is not necessarily limited to, silicate penetrate.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the concrete hardener.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in the installation of concrete hardeners with five years experience in the application of the types of materials required, and who agrees to employ only tradesmen with specific skills and experience in this type of Work. Installer shall meet the requirements of the concrete hardener manufacturer for providing guarantee coverage. Submit name and qualifications to ENGINEER.

B. Source Quality Control: Obtain all material from only one manufacturer who will send a qualified technical representative to the Work site for the purpose of advising the installer of proper procedures and precautions for the use of the material, at no additional cost to the OWNER.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer’s specifications, recommendations and installation instructions. Include manufacturer’s published data, indicating the material complies with the requirements and is intended for the application shown.

B. Certificates: Submit for approval a certificate of coverage signed by a duly authorized representative of the manufacturer.

C. Guarantee: Submit for approval written guarantee agreeing to replace the concrete hardener should it fail to perform as specified in Article 1.6, below.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in concrete hardener manufacturer's original unopened containers.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number and date of manufacturer.
      c. Mixing instructions, shelf life and curing time when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for the rejection of the material in question, by ENGINEER, and his requiring its removal from the site. In such a case, supply new material conforming to the specified requirements, at no additional cost to OWNER.
   4. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage and Handling of Materials:
   1. Store materials so as to preclude the inclusion of foreign material.
   2. Protect material from freezing.
   3. Handle materials carefully to prevent inclusion of foreign materials.
   4. Do not open containers or mix components until all necessary preparatory Work has been completed.
   5. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Do not apply concrete hardener to uncured concrete. Comply with manufacturer's written instructions for minimum ten days of curing time.
   2. Apply hardener only when temperature of concrete is 50°F or above.

B. Protection:
   1. Do not allow concrete hardener to overflow or spill onto adjoining surfaces.
   2. Remove concrete hardener that is splashed on surfaces not designated to receive concrete hardener immediately by flushing with water.

C. Sequencing:
   1. Coordinate the Work so that the concrete hardener is installed when best results will be obtained, as recommended by the manufacturer's technical representative.

1.6 GUARANTEE

A. Provide a five year written guarantee, signed by CONTRACTOR and his installer, stating that should concrete floors show signs of dusting as a result of wear and abrasion they will be re-installed, in the manner specified herein, at no additional cost to OWNER, from the date of Final Acceptance of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Hardener: Provide a clear, colorless, aqueous solution of chemically active silicates and fluosilicates plus a wetting and penetrating agent, that reacts with the free lime and calcium carbonates to bind soft, loose particles together and form a hard dense vitreous surface which is resistant to chemical attack and the growth of mildew, fungi and other organisms.

B. Product and Manufacturer: Provide one of the following:
   1. Lapidolith by Sonneborn Division of Contech Incorporated.
   2. Armortop by Anti-Hydro Waterproofing Company.
   3. Or equal.

C. Water: Potable and free of all injurious contaminants.

2.2 MIXES

A. Follow manufacturer's written instructions for the proper mixing, dilution and coverage of each coat.

2.3 FINISH

A. The finished installation of the concrete hardener shall have a smooth, uniform even finish without discontinuities or discolorations.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and the conditions under which the concrete hardener Work is to be performed and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the concrete hardener. Do not proceed with the concrete hardener Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 SUBSTRATE PREPARATION

A. Steel trowel concrete in strict accordance with printed directions supplied by the concrete hardener manufacturer.

B. Provide concrete free of all honeycombing and fins.

C. Do not use sealers, curing or parting compounds on the concrete.

D. Provide wet curing only.

E. Surfaces to receive concrete hardener shall be clean, dry and free of all loose dirt, oil, wax and other foreign matter.

3.3 INSTALLATION

A. Provide the services of a manufacturer's technical representative for the purpose of advising the installer of proper procedures and precautions for the use of the material prior and during the installation of the concrete hardener.

B. Apply concrete hardener using the coverage recommended by the manufacturer per coat.

C. Apply a minimum of three separate coats.

D. Apply a fourth coat using undiluted material should the manufacturer's technical representative recommend this procedure, based on field conditions, and as directed by ENGINEER.

E. Apply each coat by spray.

F. Mop up excess solution or puddles.

G. After each of the first and second applications, allow the floor to dry until no longer visibly wet.

H. To avoid the development of crystals, when applying the third coat, flush the surface liberally with clean, hot water. At the same time brush the floor rapidly with a stiff-bristle broom. Mop up excess water.

I. Follow manufacturer's written instructions should white crystals develop after the first or second coat. Consult manufacturer's technical representative.

3.4 ADJUSTMENT AND CLEANING

A. Clean adjacent surfaces of concrete hardener resulting from the Work. Use solvent or cleaning agent recommended by the concrete hardener manufacturer. Leave all finished Work in a clean neat appearance.

B. Protect the concrete hardener until fully cured.

+ + END OF SECTION + +

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SECTION 09 90 00

PAINTING AND COATING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and apply paint systems.
2. Provide proper surface preparation and painting of all new and existing interior and exterior items and surfaces.
3. Extent of painting is specified and includes the following:
   a. Painting shown in schedules may not provide a complete indication of all painting work. Check drawings and the coating specifications.
   b. All substrates must be prepared and painted according to their intended location, service environment per the coating manufacturer's current product data sheet for the coating (s) being used, unless specifically identified on the Drawings as a surface not to receive specified painting system.
   c. All new and specifically identified existing surfaces and items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or is specifically shown on the Drawings as indicated by written note, or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas, unless otherwise directed by ENGINEER.
   d. Heating, ventilating, and air conditioning items to be painted include, but are not limited to the following:
      1) Piping, pipe insulation, pipe hangers, and supports.
      2) Heat Exchangers.
      3) Tanks.
      4) Ductwork and insulation.
      5) Motors, mechanical equipment, and supports.
      6) Accessory items.
   e. All new and specifically identified existing surfaces and items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown on the Drawings or specified.
   f. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative toppings on those items and surfaces to remain that are identified to receive a painting system under this Section, in order to provide surfaces acceptable for application of painting system specified.
   g. Approved stepped-down mock-ups for all coating or lining systems showing all components of the surface preparation and coating or lining system application before the start of any work. Check all dry film thicknesses; demonstrate methods of surface preparation and methods of application in addition to

obtaining ENGINEER'S approval of colors and textures to be used in the work. Submit all mock ups to the ENGINEER prior to conducting the work.

B. Coordination:
   1. Review installation, schedules, removal and demolition procedures under other Sections and coordinate them with the work specified herein.
   2. Coordinate the painting of areas that will become inaccessible once equipment, laboratory furniture, lockers and similar fixed items have been installed.
   3. Coordinate primers with finish paint materials in order to provide primers that are compatible with finish paint materials used. Review other Sections and other contracts where primed surfaces are provided, to ensure compatibility of the total painting system for the various surfaces and environment service exposures. Coordinate the compatibility of all shop-primed and field-painted items in other Sections.
   4. Furnish information to ENGINEER on the characteristics of the finish materials proposed for use, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER, in writing, of anticipated problems using the specified painting systems with surfaces primed by others. Repair and re-prime all equipment primed in the factory and other factory-primed items that are damaged or scratched according to the coating manufacturers current written instructions.
   5. All shop primed items shall be re-blasted in the field and re-primed prior to being finish coated. No equipment that has been shop primed and finish coated shall be field painted, unless it has been re-blasted, re-primed and finish coated in the field.

C. Work Not Included: The following categories of Work are not included as part of the painting Work, or are included in other Sections:
   1. Shop-Priming: Shop-priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-built heating and ventilating and electrical equipment or accessories shall conform to applicable requirements of this Section but are included under other Sections.
   2. Pre-finished Items:
      a. Items furnished with such finishes as baked-on enamel, porcelain and polyvinylidene fluoride shall only be remediated at the site according to the manufacturers' written instructions and using the manufacturer's recommended compatible field-applied touchup pain
      b. Items furnished with such finishes as chrome plating or anodizing.
   3. Concrete surfaces below elevation, unless otherwise shown on the Drawings or specified.
   4. Concrete floors
   5. Face brick, glazed structural tile and prefaced, ground-faced or split-faced concrete masonry units.
   6. Exterior face of architectural precast concrete.
   7. Collector bearings, shafts and chains, wood flights, wood stop logs and wood baffles.
   8. Corrosion-Resistant Metal Surfaces: Where the natural oxide of the item forms a barrier to corrosion, whether factory- or site-formed, including such materials as copper, bronze, muntz metal, zinc, terne metal and stainless steel.
   9. Operating Parts and Labels:

a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors and fan shafts.
b. Do not paint over labels required by governing authorities having jurisdiction, or any equipment identification, performance rating, name or nomenclature plates.
c. Cover moving parts and labels during the painting Work with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings or splatter which comes in contact with such labels.

10. Structural and miscellaneous metals covered with concrete shall only receive a primer compatible with the covering material.
11. Existing structures, equipment and other existing surfaces and items, unless otherwise shown on the Drawings or specified.

D. Description of Colors and Finishes:
1. Color Selection:
a. Maximum of 4 different colors shall be selected by ENGINEER, in addition to color- coding of all pipelines, valves, equipment and ducts.
b. ENGINEER reserves the right to select all non-standard colors for all paint systems specified within the ability of manufacturer to produce such non-standard colors. CONTRACTOR shall supply such colors, at no additional cost to OWNER.
2. Color Coding of Pipelines, Valves, Equipment and Ducts:
a. In general, all color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1 and CFR 1910.144. Provide color-coding for pipelines included in Paragraph 1.1.F.3.b, Pipeline Color Table, for specified pipelines.
b. For equipment located on roofs or where exposed-to-view such as on exterior building facades, or in offices or lobbies, the color shall be selected by ENGINEER.
3. Color Coding of Pipelines and Equipment:
a. Finish coats of paint for pipelines and equipment shall be coded in basic colors. Colors shall be brilliant, distinctive shades matching the following safety colors in accordance with ANSI Z535.1 color specifications for safety colors and other primary colors:

TABLE OF STANDARD COLORS

COLOR	**DESIGNATION**
Black	Black - 35GR
Blue	Safety Blue - 11SF
Brown	Chipmunk - YB23
Charcoal	Graphite - GR32
Gray	Gray-ANSI 61 - 33GR
Green	Safety Green - 09SF
Light Gray	Light Gray - 32GR
Light Green	Misty Jade - GB38
Orange	Safety Orange - 04SF
Red	Safety Red - 06SF
White	White - 00WH

Yellow	Safety Yellow - 02SF
D. Gray	Sinker - 46GR
Lt. Blue	Clear Sky - 26BL
Dk. Blue	KC Blue - 21BL
Medium Green	Linden - 27GN
Dk. Green	Hunter Green - 08SF
Purple	Safety Purple - 14SF

*Color designations are provided as Tnemec Company, Incorporated paint color numbers and are provided as a standard of quality; equivalent colors matching these colors will be acceptable to ENGINEER. Provide ENGINEER with direct color comparisons of color numbers available from manufacturer submitted at time of Shop Drawing submission.

4. General Color Code: Unless otherwise specified, the following color code shall be used:

PIPING AND SIGN COLOR CODE

WATER			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Spray Water	Red	Black	Red
Potable Water	Lt. Blue/White Bands	Black	Blue
Seal Water	Red	White	Red
Chilled Water Return	Blue	White	Green
Chilled Water Supply	Blue	White	Green
Cold Water	Blue	White	Green
Hot Water Return	Blue/Red Bands	Black	Yellow
Hot Water Supply	Blue/Red Bands	Black	Yellow
Non-Potable Water (Reuse Water)	Red/Black Bands	White	Red

WATER LINES			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Water - Potable	Lt. Blue	Black	None
Water - Potable (HOT)	Lt. Blue	Black	Red
Water - Deionized	Lt. Blue	Black	None
Water - Raw	Dk. Green	Black	Lt. Gray
Water - Non Potable (Plant Water)	Lt. Blue	Black	Purple
Water - Non Potable (Reuse)	Purple	Black	None

SAMPLE LINE PIPING			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Raw Water	Dk. Blue	White	Black
Non Raw Water	Dk. Blue	Black	Lt. Blue

AIR AND GAS			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Process Air	White	Black	White
Chlorine Gas	Yellow/Green Bands	White	Yellow
Natural Gas	Red	Black	Yellow
Digester Gas, H.P.	Red	Black	Yellow
Digester Gas, L.P.	Red	Black	Yellow
High Pressure Air	White/Red Bands	Black	White

CHEMICALS			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Ferric Chloride	Safety Orange	Black	Safety Orange
Chlorine Solution	Yellow	Black	Yellow
Liquid Polymer	Yellow	Black	Yellow
Polymer Feed	Yellow	Black	Yellow
Methanol	Yellow	Black	Yellow
Sodium Hydroxide	Yellow	Black	Yellow
Sodium Hypochlorite	Yellow	Black	Yellow
Hydrochloric Acid	Yellow	Black	Yellow

PROCESS			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Primary Effluent	Brown	Black	Green
Digester Tank Drains	Brown	Black	Green
Floor Drains	Gray	Black	Green
Settling Tank Drains	Gray	Black	Green
Storage Tank Drains	Gray	Black	Green
Storm Drains	Gray	Black	Green
Sump Drains	Gray	Black	Green
Mixed Liquor	Brown	Black	Green
Scum	Black	Black	Green
Sewage D.	Gray	Black	Green
Sewage Sampling Lines	D. Gray	Black	Green
Sludge	Brown	Black	Green
Digested Sludge	Brown	Black	Green

Primary Sludge	Brown	Black	Green
Raw Sludge	Brown	Black	Green
Recirculated Digester Sludge	Brown	Black	Green
Return Activated Sludge	Brown	Black	Green
Waste Activated Sludge	Brown	Black	Green
Supernatant	Black	Black	Green
Digester Tank Overflow	Brown	Black	Green
Storage Tank Overflow	Brown	Black	Green
Grit Lines	Brown	Black	Yellow
Grit Overflow	Brown	Black	Yellow
Grit Dewatering	Brown	Black	Yellow
Centrate Lines	Gray	Black	Yellow
Sludge Cake Lines	Brown	White	Green
Scrubber Blowdown	Yellow	Black	Yellow

PROCESS CHEMICAL SOLUTIONS			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Alum	Medium Green	Black	None
Ferric Chloride	Orange	White	Black
Polymer - Coagulant	Lt. Green	Green	Lt. Blue
Polymer - Filter Aid	Lt. Green	White	Dk. Blue
Polymer - Thickener	Lt. Green	White	Dk. Blue
Polymer - Centrifuge	Lt. Green	White	Dk. Blue
Polyphosphate	Medium Green	Black	None
Carbon	Black	White	None
Sulfuric Acid	Yellow	Black	Red
Caustic Soda	Dk. Green	White	None
Lime	Medium Green	Black	None
Fluoride	Yellow	Black	Lt. Blue
Copper Sulfate	Medium Green	Black	Blue

DISINFECTANTS			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Chlorine - Gas	Yellow	Black	Green
Chlorine - Liquid	Yellow	Black	None
Chlorine - Solution	Yellow	Black	None

PLANT AIR			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Plant Air Piping	White	Black	None
High Pressure Air Piping	White	Black	Red

WASTEWATER			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Domestic Wastewater	Gray	Black	None
Process Wastewater	Gray	Black	Lt. Blue

FIRE QUENCHING MATERIALS		
Water, Foam, CO2, Halon, Fire Hydrants, including sections of potable water for Fire Dept. access (no label)		
PIPING COLOR	**LETTERING COLOR**	**BACKGROUND COLOR**
Red	None	None

USED WATER RECOVERY FACILITIES			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Floor Drains	Gray	Black	Green
Settling Tank Drains	Gray	Black	Green
Storage Tank Drains	Gray	Black	Green
Sump Drains	Gray	Black	Green
Scum	Brown	Black	Green
Sludge	Brown	Black	Green
Storage Tank Overflow	Brown	Black	Green

OTHER			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Lube Oil	Brown	White	Brown
Waste Oil	Brown	White	Brown
Roof Drains	Gray	Black	Green
Methanol Solution	Yellow	Black	Yellow
Natural Gas	Orange	Black	Lt. Blue

5. After approval by ENGINEER of colors and Shop Drawing submittals and prior to beginning painting Work, ENGINEER will furnish color schedules for surfaces to be painted.
6. Abbreviations and Symbols:

a. Abbreviations and symbols used in Tables are explained in Article 2.2, below, and provide information on generic composition of the required materials, manufacturers, number of coats and their dry mil film thickness per coat (DMFTPC) and coverage for calculating the required number of gallons for the Work.

1.2 REFERENCE STANDARDS

A. Insure all referenced standards are used according to the standard's most current version.

B. ASTM International (ASTM):
1. ASTM C 1538/1538M, Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method
2. ASTM D 16, Standard Terminology Relating to Paint, Varnish, Lacquer and Related Products
3. ASTM D 3359, Methods for Measuring Adhesion by Tape Test. Method A.
4. ASTM D 3960, Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coating
5. ASTM D 4227, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces
6. ASTM D 4228, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces
7. ASTM D 4258, Practice for Surface Cleaning Concrete for Coating.
8. ASTM D 4259, Practice for Abrading Concrete.
9. ASTM D 4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
10. ASTM D 4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surface
11. ASTM D 4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
12. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed Air.
13. ASTM D 4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel. Methods B or C
14. ASTM D 4541, Test Method for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
15. ASTM D 6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
16. ASTM D 7234, Pull-Off Adhesion test of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
17. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials
18. ASTM E 797/797M, Measuring Thickness by Manuel Ultrasonic Pulse-Echo Contact Method
19. ASTM F 22, Hydrophobic Surface Films by the Water Break Test
20. ASTM F 1869, Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
21. ASTM F 2170, Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes the Identification of Piping Systems.

C. American National Standards Institute (ANSI)/NSF International (NSF)
   1. ANSI A13.1, Scheme for the Identification of Piping Systems
   2. ANSI Z535.1, Safety Color Code.
   3. ANSI/NSF Standard 60, Drinking Water Chemicals - Health Effects.
   4. ANSI/NSF Standard 61, Drinking Water System Components - Health Effects.

D. NACE International (NACE)
   1. NACE SP0188, (Standard Practice Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates0
   2. NACE SP0892, Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service.
   3. NACE Publication 6D-173, A Manual for Painter Safety

E. National Bureau of Standards (NBS)
   1. Certified Coating Thickness Calibration Standards.

F. National Fire Protection Association (NFPA)
   1. 101, Life Safety Code.

G. The Society for Protective Coatings (SSPC)
   1. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements (Level 3)
   2. SP 1, Solvent Cleaning
   3. SP 2, Hand Tool Cleaning
   4. SP 3, Power Tool Cleaning
   5. SP-15, Commercial Grade Power-Tool Cleaning
   6. SSPC Painting Manuel Volume 1, Good Painting Practice Structures
   7. SSPC - Volume 2, Systems and Specifications.
   8. SSPC - VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
   9. SSPC - VIS 2, Visual Standard for Evaluating Degree of Rusting on Painted Steel Surfaces
   10. SSPC VIS 3, Guide and Reference Photographs for Steel Surfaces Prepared By Power and Hand Tool Cleaning
   11. SSPC Guide 6, Containing Debris Generated During Paint Removal Operation
   12. SSPC Guide 12, Guide for Illumination of Industrial Projects

H. The Society for Protective Coatings/NACE International (SSPC/NACE)
   1. SP 5/NACE NO. 1, White Metal Blast Cleaning
   2. SP 10/NACE No. 2, Near-White Blast Cleaning
   3. SP 6/NACE No.3, Commercial Blast Cleaning
   4. SP 7/NACE No. 4, Brush-off Blast Cleaning
   5. SP 13/NACE No. 6, Surface Preparation of Concrete

I. National Association of Pipe Fabricators, Inc. NAPF 500-03 (SURFACE PREPARATION STANDARD FOR DUCTILE IRON PIPE AND FITTINGS IN EXPOSED LOCATIONS RECEIVING SPECIAL EXTERNAL COATINGS AND/OR SPECIAL INTERNAL LININGS
   1. 500-03-01, Solvent Cleaning
   2. 500-03-02, Hand Tool Cleaning
   3. 500-03 -03, Poor Tool Cleaning

4. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe
5. 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings

J. The International Organization for Standardization (ISO)
1. ISO 8502-3, Preparation of steel substrates before application of paint and related products -Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)

K. Code of Federal Regulations
1. 29 CFR 1910.144, Safety Color Code for Marking Physical Hazards

1.3 DEFINITIONS

A. Specific coating terminology used in this Section shall be in accordance with the definitions in ASTM D 16, ASTM D 3960 and the following definitions:
1. The term "paint" includes pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate or finish coats.
2. The term “resurfacer” as used herein means an epoxy polymer modified cementitious material used to restore the concrete substrate to provide a contiguous concrete surface for subsequent lining materials.
3. The term “coating” and “lining” as used herein are considered interchangeable and mean coating systems materials, including any applicable resinous primers and finish coats that function to provide protection of steel or concrete substrates.
4. The terms “coating system” and “lining system” as used herein are considered interchangeable and mean all total resurfacing and coating materials combined to function as a total system to provide the designed protection
5. The term "exposed" means all items not covered with cement plaster, concrete or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. Exposed-to-view surfaces also include those areas visible after permanent or built in fixtures, convector covers, ceiling tile, covers for finned tube radiation, grilles, etc. are in-place, in areas scheduled to be painted.
6. Dry Film Thickness (DFT): The thickness of one fully cured continuous application of coating.
7. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the Work.
8. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.
9. Barrier Coat:. A physical barrier, i.e. coating, between the substrate and it’s environment by keeping oxygen, moisture and other chemicals away from the substrate
10. Photochemically Reactive Organic Material: Any organic material that will react with oxygen, excited oxygen, ozone or other free radicals generated by the action of sunlight on components in the atmosphere giving rise to secondary contaminants and reaction intermediates in the atmosphere which can have detrimental effects.

11. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter or pounds per gallon.
12. Touch-Up Painting: The application of a paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
13. Painter: Installer or applicator is the person or persons actually installing or applying the coating and/or lining in the field at the Project site.
14. The term Independent NACE CCI 3: The inspection body and its staff shall not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular they shall not become directly involved in the design, manufacture, supply, installation, user or maintenance of the items inspected, or similar competitive items. They are also a person and/or persons (NACE Certified Coating Inspector) that has satisfactorily completed NACE CIP program and is still actively certified by NACE International.
15. Approved Factory Finish: Finish on a product in compliance with the finish specified in the section where the product is specified.
16. Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to frequent condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or chronic exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range of 5 - 9.
17. Highly Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to frequent condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or chronic exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range below 5 or above 9.
18. Holiday: A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating. May also be identified as a holiday or pinhole.
19. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.
20. Exposed Surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.
21. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils (1/1000 inch).
22. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.
23. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

1.4 QUALITY ASSURANCE

A. Applicators' Requirements
   1. If any requirements of this specification in conflict with a referenced standard, the more stringent requirement shall apply.

2. Minimum of 10 (ten) years of experience regularly performing the application of coating and/or lining materials, with documented skill and successful experience in the application of the types of materials.
3. Submit list of projects of similar size and complexity along with names of persons and their work experience. This must include evidence of worker training and qualification programs. Only those submitted and approved persons by the ENGINEER will be permitted to work on the project.
4. Qualifying experience shall include at least three previous projects of similar magnitude and complexity to this project that have been completed not less than 18 months prior to submission of qualifications to ENGINEER.
5. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
   a. Name of project
   b. Names and telephone numbers of owners, architects or engineers responsible for projects.
   c. Approximate contract cost of the paint materials.
   d. Amount of area installed.
6. Submit in writing to the ENGINEER acceptability by the coating manufacturer.
7. Personnel are to be completely trained and experienced in the proper use of all specified/submitted coating and lining materials, surface preparation and application equipment being used for the project. No person shall work on this project unless they have been previously approved by the ENGINEER.

B. Source Quality Control
1. Obtain materials only from manufacturers who will provide the services of a qualified manufacturer's representative at the site at the commencement of painting Work to advise on materials, mock-ups, installation and finishing techniques, at the completion of the Work to advise ENGINEER on the acceptability of completed Work, and during the course of the Work as may be requested by ENGINEER.
2. Certify long-term compatibility of all coatings with intended service exposures.
3. Do not submit products that do not meet or exceed the performance criteria. All submitted coating and/or lining system must be able to provide long-term protection and performance within its intended service environment. Products exceeding current VOC limits will not be approved.
4. ENGINEER may review manufacturer’s recommendations concerning methods of installation and number of coats of paint for each painting system. Prepare cost estimates based on painting systems, number of coats, coverages and installation methods specified.
5. All proposed "or equal" products shall be submitted 20 working days prior to the beginning of work with direct comparison to products specified including information on performance criteria adhesion, color and gloss retention, percent solids, VOC's per gallon, application methods, case histories and re-coat ability after curing etc.
6. "Equal or better" manufacturers shall furnish the same color selection as the manufacturers specified, including intense chroma and custom pigmented colors in all painting systems.
7. Color Pigments: Provide pure, nonfading, applicable types to suit the surfaces and services indicated. Comply with the following:
   a. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by governing authorities having jurisdiction.

b. Areas subject to hydrogen sulfide fume exposure shall be identified by ENGINEER. Manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in such areas.
c. Comply with manufacturer's recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.

8. Obtain each product from only one manufacturer. Multiple manufacturing sources for the same system component will not be approved by ENGINEER.
9. Certify product shelf life history for each product source for materials manufactured by the same manufacturer, but purchased and stored at different locations or obtained from different sources.
10. Constantly store materials to be used in the painting according with the manufacturers approved current written recommendations, for not more than six months. Certify to ENGINEER that painting materials have been manufactured within six months of installation and have not, nor will be, subjected to freezing temperatures.
11. Provide the services of a qualified manufacturer's representative to the Project site to observe the initial commencement of surface preparation and each coating's application. Manufacturer's representative will advise on materials, surface preparation, coating applications and finishing techniques. Once completed the manufacturer's representative will provide a written report certifying that all observed surface preparation and coating application(s) have been completed according to the manufacturer's current recommendations and requirements. This certification report must be received 7 (seven) calendar days after the last site visit by the manufacturer.
12. Provide in writing that the specified and applied coating or lining system is the correct system for the long-term protection and performance of the environmental exposures it will be subjected.
13. Provide the services of a qualified manufacturer's representative to the Project site at the completion of work to inspect the Work. The qualified manufacturer's representative to provide a manufacturer's report stating any deficiencies in the coatings system, if any, noted during the final inspection. The report must be submitted to the ENGINEEER 7 (seven) calendar days after the last site visit by the manufacturer.
14. Following the completion of the corrective measures, provide the services of an independent NACE CCI to re-inspect the work. Within 7 (seven) days after re-inspection, the independent NACE CCI will provide a written report to the ENGINEEER stating that the coatings have been applied properly and in accordance with the manufacturer's written recommendations and requirements.

C. Testing Qualifications: To qualify for approval, provide all required documented performance criteria and project cases histories of more than 5 (five) years of service in similar or more severe environments. Provided information must clearly demonstrate to ENGINEER'S satisfaction that the submitted coating or lining system performance criteria data and project case histories meets or exceeds the projects intended environmental service requirements.

D. Stepped-Down Mock-Ups:
1. Demonstrate installation of specified coating or lining system(s) on actual surfaces and building components at locations selected by ENGINEER.

2. Once the ENGINEER has approved in writing all the components of coating or lining system. Provide a 3 foot by 3 foot (minimum) stepped-down sample area for each specified system according to specified manufacturer's most current written application recommendations. Each surface preparation and application step shall remain exposed in order to demonstrate the Work performed by that step. Each step of the mock up must be approved in writing by the ENGINEER and coating manufacturer representative. Continue application procedures until topcoat is provided.
3. Finished mock-up for each coating or lining system, when completed, shall reveal each step and each coat of paint required for the specified. Mock up standard must be protected and preserved until the application completion and written acceptance of the work for that particular specified system. Use tinted shades differing from coat to coat for each component of each painting system. All mock-up work must be done by person(s) that will actually be doing the work on the project. Utilize ASTM D 4227 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces or ASTM D 4228 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces.
4. ENGINEER may approve or disapprove each component of each painting system on an individual component basis.
5. Coating or lining system Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material.
6. Coating or lining system Work advanced without approved mock-ups shall be stopped, and mock-ups prepared for approval by ENGINEER. If any coatings or linings have been applied before an approved mock up standard has been agreed upon in writing by all parties, the ENGINEER has the authority to have those applied coatings or linings completely removed and reapplied at CONTRACTORS expense.

E. Requirements of Regulatory Agencies: Surface preparation and application of coatings shall be performed in compliance with all applicable federal, state and local occupational safety and health regulations and Maricopa County Air Pollution Control Regulations. Insure that all required certifications for all regulatory agencies current and readily available upon request.
   1. Obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins and as required by applicable regulations. Provide forced ventilation in all areas where inadequate ventilation exists.
   2. Painting systems for surfaces in contact with potable water, or water being treated for potable use, shall be NSF approved and shall not impart any taste or odor to the water or result in any organic or inorganic content in excess of the maximum allowable contaminant level established by governing authorities having jurisdiction. All such painting systems shall be approved by the applicable regulatory agency. Revise painting systems specified herein to provide manufacturer's regulatory agency approved painting system(s) where required.
   3. Comply with the regulations of governing authorities having jurisdiction for air quality and material disposal regulations. Revise painting systems specified herein in order to provide manufacturer's regulatory agency approved painting systems, where required.
   4. Comply with governing authorities having jurisdiction for blast cleaning operations, confined space entry and disposition of spent abrasive and debris.

F. Pre-Application Meeting:
   1. A pre-application meeting MUST take place at the job-site or mutually agreed upon site a minimum 3 (three) weeks before the application of any coating or lining work proceeding. Attendance is required of all principal decision making parties directly affecting work of this section, including OWNER, ENGINEER, CONTRACTOR, COATING MANUFACTURER'S REPRESENTATIVE and COATING INSPECTOR etc. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures relating to the painting Work, including but not necessarily limited to, the following:
      a. Review Project Coating Specification, Project requirements, including Contract Documents, Project Schedule, approved Shop Drawings, pending and approved Change Orders and requests for information.
      b. Field quality control: Contractors responsibilities, i.e providing written daily reports and review required samples and submittals, both completed and yet to be completed.
      c. Review status of surfaces including drying, surface preparations and similar considerations.
      d. Review availability of materials, tradesman, equipment and facilities needed to make progress, avoid delays and protect the Work from damaging conditions.
      e. Coating Inspector's authority and responsibilities, required inspections, testing services, certifications and quality control procedures.
      f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions. Supplemental heating sources, as may be required to continue the Work under low temperature conditions, shall be in operating order and acceptable to paint applicator.
      g. Review methods for complying with regulations of governing authorities having jurisdiction, such as compliance with environmental protection, health, safety, fire and similar regulations.
      h. Material storage requirements
      i. Protection of surfaces not scheduled to be coated
      j. Application requirements and procedures
      k. Protection of coating systems
   2. Provide meeting minutes to all parties for review and possible clarification. Should any correction to the meeting minutes be required, the minutes should be corrected and resubmitted to all parties.
   3. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.
   4. Record any revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

G. Maintain a Paint Application Log containing the information as shown on the log attached at the end of this Section. The Paint Application Log shall be maintained on a daily basis for all areas where the Work is being performed. The Paint Application Log shall be turned over to the ENGINEER by 9:00 a.m. the following day that the work was performed. The log shall include the following:
   1. Date.
   2. Time.
   3. Weather condition (at work location).
   4. Air temperature (at work location).

5. Surface temperature (at work location).
6. Dew point (at work location).
7. Humidity (at work location).
8. Material temperature (Before (Separately) and Mixed (Combined)
9. Location/area square footage.
10. Description of Work performed.
11. Materials used, colors and batch numbers, quantity of materials used (not including waste).
12. Application/surface preparation equipment and personnel.
13. WFT/surface profile measurements.
14. Comments, quality control procedures.
15. Signature/title.

1.5 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Copies of manufacturer's complete color charts for each coating system.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's current technical information and test performance data, including paint analysis, VOC content in comparison to current legal maximum limits allowed, and current application instructions for each material proposed for use.
   2. Submit Applicator's Qualifications in accordance with 1.4 Quality Assurance. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's current written application instructions for submitted coating and/or lining systems.
      c. Manufacturer’s current written repair procedure for the submitted coating and/or lining system.
      d. Manufacturer’s current written repair procedure for the submitted coating and/or lining system.
      e. Manufacturer's current surface preparation instructions for submitted coating and/or lining systems.
      f. Manufacturers current written repair procedures for submitted coating and/or systems
      g. Written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
      h. Coating manufacturer's recommendation on abrasive blasting or other acceptable surface preparation techniques.
      i. Coating manufacturer's recommendation for universal barrier coat if required.
      j. Coating manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
   4. Coating manufacturer's statement regarding applicator instruction on product use.
   5. Provide certification that the coating and/or lining systems proposed for use has been reviewed and approved by Senior Technical Service Representative or equivalent employed by the coating manufacturer.

6. Provide a certification from the local coating manufacturer's representative that they have inspected all surfaces with existing coatings and certify that the products are compatible with the existing coatings and the surface preparation requirements required by this Section where appropriate. This certification will be based upon written documented results of an adhesion test (s) performed by a qualified independent NACE CCI Level 3 or Level 2 if directly supervised by a NACE CCI Level 3.
7. Provide all appropriate air quality permits for abrasive blast operation, if required by local, county, state or federal laws or ordinances.

C. Samples:
   1. Manufacturer's full line of colors for Engineer's preliminary color selection.
   2. After preliminary color selection by Engineer provide two (2) 3 x 5 inch samples of each final color selected.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging,
with labels clearly identifying.
   1. Coating or material name
   2. Manufacture
   3. Color name and number
   4. Batch or lot number
   5. Date of manufacture.
   6. Mixing and thinning instructions.
   7. Federal Specification Number if applicable.
   8. Application and mixing instructions.
   9. Hazardous material identification label
   10. Shelf life date.
   11. Storage requirements. Submit storage and application temperature requirements for all coating system materials

B. Storage of Materials:
   1. Store materials in a clean dry area and within temperature range according to the coating
   manufacturer's current written instructions
   2. Keep containers sealed until ready for use.
   3. Do not use materials beyond manufacturer's shelf life limits.
   4. All coating shall be delivered to the shop or job site in original, unopened containers with labels intact. Minor damage to containers is acceptable provided the container has not been punctured or the lid seal broken.
   5. Each container of coating shall be clearly marked or labeled to show coating identification, date of manufacture, batch number, and other information as needed to meet regulatory requirements. Each type of coating shall be accompanied by the manufacturer's Material Safety Data Sheet (MSDS) and product data sheet containing information such as basic chemical composition, acceptable weather conditions for application, and proper storing and mixing.

6. All containers of coating shall remain unopened until required for use. No more containers of coating shall be opened than will be applied that day. The label information shall be legible and shall be checked at the time of use.
7. Coating which has livered, gelled, or otherwise deteriorated during storage shall not be used; however, thixotropic materials which can be stirred to attain normal consistency may be used.
8. The oldest coating of each kind that is in acceptable condition shall be used first. In every case, the coating is to be used before its shelf life has expired. Materials exceeding storage life recommended by the Manufacturer shall be removed from the site.
9. Coatings shall be stored in original unopened containers in weather tight spaces where the temperature is maintained between 60 °F and 90 °F unless otherwise recommended in writing by the manufacturer. The coating temperature shall be brought to the coating manufacturer current written recommended application temperature before use. Materials shall be stored according to the manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions.
10. Flammable materials shall be stored according to state and local codes.
11. Store all materials only in area or areas designated by the ENGINEER. Confine mixing, thinning, clean up and associated operations, and storage of materials related debris before authorized disposal, to these areas. All materials are to be stored on pallets or similar storage handling skids off the ground.
12. Mix all lining materials in an enclosed mixing area designated by the ENGINEER. This enclosed area must protect the mixing operation and materials from direct sunlight, inclement weather, freezing, or other means of damage or contamination. Protect all other concrete and metallic surfaces and finishes from any spillage of material(s) within the mixing area. The material temperature should be between 70o F and 90o F before application, unless noted otherwise on the current product data sheet.
13. Do not use floor drains, dikes or storm drains for disposal of coating system materials. Provide for the safe removal and lawful disposal of all waste materials.
14. Take all precautions and implement all measures necessary to avert potential hazards associated with the resurfacing system materials as described on the pertinent Material Safety Data Sheets or container labels.
15. Deliver all materials to the job site in their original, unopened containers. Each container shall bear the Manufacturer's name and label.
16. Maintain the storage and the environmental climate of that area for all coating materials that they will be using unless otherwise agreed upon.
17. Handling: Protect materials during handling and application to prevent damage or contamination.

1.7 SAFETY

A. Conduct the following safety items:
   1. Comply with all federal, state and local regulations as well as with the provisions outlined in NACE Pub. 6D-173, "A Manual for Painter Safety"
   2. Provide personnel with all safety equipment necessary to protect them during any phase of the work according to all current OSHA Standards.
   3. Adhere to all OSHA requirements with regard to permitted confined space including providing all equipment and personnel necessary.

4. Erect and maintain scaffolding according to OSHA standards.
5. No work shall be performed until the appropriate Work Requests and Lockouts are approved by the ENGINEER. The Work Request system provides a mechanism to advise plant staff of a contractor's work activities. The Lock Out /Tag Out system is a safety procedure to prevent unintended equipment activation.
6. Keep any flammable materials such as cleaning solvents, thinners, or resurfacing materials away from open flames, sparks or temperatures higher than 150 F. Drums containing flammable materials shall be grounded. Flammable materials not being utilized shall be maintained in their on-site storage area.
7. Power tools are to be in good working order to avoid open sparking. No spark producing tools shall be utilized in restricted areas as indicated herein.
8. Maintain a clean work area and furnish Underwriter's Laboratories approved fire extinguishers on-hand.
9. Workers performing abrasive blasting operations shall wear a fresh air supplied protective helmet and hood and personal protective clothing acceptable to industry standards and all government regulations.
10. Workers performing coating operations shall wear the appropriate personal protective equipment, clothing, and NIOSH approved respirator acceptable to industry standards and all government regulations.
11. Dispose of rags used for wiping up resurfacing materials, solvents, and thinners by drenching them with water and placing in a metal container with a tight fitting metal cover. Complete this disposal process at the end of each day. Final disposal of these materials is the CONTRACTORS's responsibility.
12. Matches, flames, or sparks resulting from any source including welding, must be removed from the work area during coating work. Smoking is NOT permitted accept for designated areas.

1.8 PROJECT CONDITIONS

A. Site Facilities:
   1. Supplemental heat sources, as may be required to maintain both ambient and surface temperatures within the range recommended by the manufacturer for paint system applications, are not available at the site.
   2. Provide provisions for all supplemental heat energy sources, power, equipment and operating, maintenance and temperature monitoring personnel.
   3. Do not use heat sources, which emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent all such heat sources to the exterior such that paint systems are unaffected by exhaust products.

B. Existing Conditions:
   1. Provide lighting (If Required) for all work areas as prescribed in SSPC Guide 12
   2. Existing materials specified to be painted as part of the Work shall have their surfaces prepared to meet the requirements of the painting systems specified. Where existing paint systems will provide the substrate for painting systems specified, provide adhesion testing on existing surfaces to be painted according to the coating manufacturers recommendations. Abrasive blasting, scraping or other abrading or surface film removal, or preparatory techniques as approved by ENGINEER shall be provided as part of the Work.

3. Before painting is started in any area, all surfaces to be painted and floors shall be cleaned of all dust using commercial vacuum cleaning equipment and dust containment.
4. Apply coatings to dust free surfaces. Test surfaces for cleanliness according to ISO 8502-3 (Preparation of steel substrates before application of paint and related products -Tests for the assessment of surface cleanliness - Part 3 Assessment of dust on steel surfaces prepared for painting (pressure- sensitive tape method). Randomly test prepared surfaces at rate of 8 tests for the first 1000 square feet. Afterwards conduct 3 tests for each additional 1000 square feet. Provide 3 additional tests for each failed test or questionable test. Turn in test tapes results with Daily Inspection Reports.
5. After painting operations begin in a given area cleaning shall be done only with commercial vacuum cleaning equipment and dust containment systems.

C. Environmental Requirements
1. If required to maintain project schedule, Provide and utilize dehumidification and ventilation equipment to control humidity, temperature, and vapor levels in from beginning of the surface preparation process through coating application and for seven days after the last coating is applied. System shall maintain vapor concentrations at or below 10 percent of Lower Explosive Limit (LEL). System may incorporate any combination of solid desiccant and direct expansion refrigeration equipment. No liquid, granular, calcium chloride, or lithium chloride drying systems will be accepted. Use only electric, indirect fired combustion, indirect friction, or steam coil auxiliary heaters. System shall be compatible with removal of dust and solvent vapors, and shall have fail-safe measures to ensure reliability during operations.
2. If dehumidification and ventilation equipment is not already being used, ventilate interior areas such as water tanks (potable or non-potable) and other containment service areas according to written procedures outlined by the ENGINEER and/or the coating manufacturer.
3. Provide enclosures for other areas or items that may require protection from the inclement weather or other detrimental effects so the project can continue.
4. Apply water-base paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 55°F and 90°F, unless otherwise permitted by the paint manufacturer's current printed instructions.
5. Surfaces to be painted shall dry to the touch and at least 5°F above the dew point temperature and rising. Apply paints only when the temperature of surfaces to be painted, paint material, and the surrounding air temperatures are between 65°F and 95°F, unless otherwise permitted by the paint manufacturer's current printed instructions.
6. Apply paint system within the shortest possible time consistent with manufacturer's approved recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, it shall be removed according to the coating manufacturer written recommendation, and the surface restored before applying the remainder of the coatings.
7. Tanks containing water shall not be painted without specific permission of ENGINEER, and only under conditions where "sweating" of the tank outside surface is not likely to occur within 24 hours of application.
8. Epoxy paints shall not be applied if ambient temperature is expected to go below 50°F within 12 hours of application. Where manufacturer's printed

recommendations require a higher minimum ambient temperature, this shall be followed.

9. Do not apply paint in rain, fog or mist; or when the relative humidity exceeds 85 percent; to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during the course of the paint application, unless otherwise permitted in writing by the paint manufacturer's printed instructions.
10. Do not paint pipelines and other hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to manufacturer. Arrange for such surfaces to be brought within acceptable temperature and dew point ranges as part of the painting Work.
11. On substrates such as wood, concrete etc, use methods recommended by the specified manufacturer, the measured moisture content of surfaces shall be verified by the ENGINEER as acceptable prior to the commencement of the painting.
12. Painting may continue during inclement weather only if the areas and surfaces to be painted are enclosed and ambient conditions can be maintained continuously as specified by the paint manufacturer during application and drying periods.
13. Provide adequate illumination (SSPC-Guide 12) and ventilation in all areas where painting operations and inspections are in progress.
14. Install piping markers only after all painting and finish work has been completed and cured.

D. Protection:
   1. Cover or otherwise protect finished Work of other trades and surfaces not being painted concurrently or not to be painted.
   2. During surface preparation and painting, the facility shall remain in operation. Employ procedures that prevent contamination of the process or cause facility shutdown.
   3. Coordinate and schedule surface preparation and painting to avoid exposing employees and others not involved with surface preparation and painting. Provide required personnel safety equipment in compliance with the requirements of governing authorities having jurisdiction.
   4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work in any area until ENGINEER approves protection techniques proposed.
   5. Provide fire extinguishers and post caution signs warning against smoking and open flame when working with flammable materials.

E. Spent abrasive containing lead and/or chromate paint resulting from the blasting of the "affected surfaces" is classified as a hazardous waste. "Spent abrasive" shall be understood to mean the abrasive generated during the blasting operation, including the spent water imposed over the abrasive flow, paint residue and any other debris.

F. Care shall be exercised to prevent spent abrasive, water or dust from falling on surrounding buildings, unprotected vegetation, walkways, soils, structures and equipment by covering these areas with non-tearing tarps. Spent abrasive collecting on the ground shall be vacuumed regularly to prevent it from becoming windblown. The site shall at all times be kept as clean as possible. At the end of the Work day, all spent abrasive shall be thoroughly vacuumed and the site left with a neat appearance.

G. Spent abrasive resulting from the blasting of the "affected surfaces" shall be captured. Non-tearing tarps or plastic sheathing, platforms, partial or total enclosures, temporary barriers or structures, or similar containment methods may be employed for this purpose. These methods must be reviewed by the ENGINEER prior to start of the Work. Provide a detailed procedure describing the proposed blast cleaning operation, abrasive capture and containment techniques, and safety measures to avoid the contamination of the natural environment or surrounding structures.

H. Spent abrasive resulting from the blasting of the "affected surfaces" shall be collected and legally disposed of by the CONTRACTOR in a legal and responsible manner. Such disposal shall also be in conformance with all applicable codes, ordinances and regulations for hazardous waste disposal. All other waste, including spent abrasive generated by the blasting of non-affected surfaces, shall be disposed by the CONTRACTOR.

I. All reasonable care shall be taken to protect against paint splatter and overspray. Responsibility for any damage incurred to surrounding property resulting from this work belongs to the CONTRACTOR.

J. Signs shall be posted, as required, to alert the public of any risks associated with sandblasting debris, painting overspray, etc. All efforts shall be made to prevent debris from becoming windblown.

K. Obtain all permits required to perform the Work.

L. Spent water, resulting from the cleaning operation of "affected surfaces" due to wet sandblasting, may contain hazardous particulates, shall be disposed by CONTRACTOR.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Specification basis of design is Tnemec.

B. Or Equal: Subject to meeting these specifications requirements. The following manufacturers may be acceptable.

C. Submit system proposed as “Equal” for review and approval as required by ENGINEER.
   1. Sherwin Williams
   2. Carboline
   3. Ameron/PPG
   4. International

2.2 PAINTING SYSTEMS

A. New and Existing Cast-In-Place Concrete Walls (except walls within the height of chemical containment dike wall areas), Columns, Underside of Roof Slabs and Beams, Architectural Precast Concrete; Non-Submerged, Interior. (LEED Compliant through Version 3.0)

B. Severe Exposure
   1. Surfacer/Filler (Epoxy Modified Cementitious Mortar)
      a. Tnemec Series 218 MortarClad; 1 parge coat trowel applied; nominal 1/16 inch minimum DFT (actual DFT to depend on the depth of the profile in the concrete after abrasive blasting.)
   2. Primer (Modified Polyamine Epoxy Penetrating Epoxy)
      a. Tnemec Series 201 EpoxoPrime; 1 coat; 6-8 mils DFT
   3. Base Coats (Fiberglass Reinforced Polyamine Epoxy)
      a. Tnemec Series 270 Stranlok; 2 coats; 25-40 mils Total DFT
   4. Finish Coat (Modified Polyamine Epoxy)
      a. Tnemec Series 280 Tnemec Glaze; 1 coat; 6-8 mils DFT

C. Moderate Exposure
   1. Surfacer/Filler (Epoxy Modified Cementitious Mortar)
      a. Coating 1. Tnemec Series 218 MortarClad; 1 parge coat trowel applied; nominal 1/16 inch minimum DFT (actual DFT to depend on the depth of the profile in the concrete after abrasive blasting.)
   2. Primer (Polyamidoamine Epoxy)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
   3. Finish Coat (Polyamidoamine Epoxy)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

D. To the extend shown on the DRAWINGS, new and existing cast-in-place concrete floors, equipment pads, sumps, trenches, walls, columns and all other cast-in-place concrete within chemical containment areas. Comply with manufacturer's current written recommendations for mixing, curing and application.
   1. Patch /Filler/ Surfacer (Epoxy Modified Cementitious Mortar)
      a. Tnemec Series 218 MortarClad; Trowel applied as needed
   2. Primer (Modified Novolac Polyamine Epoxy)
      a. Tnemec Series 239SC Chembloc RCK (Resin Containment Kit); 1 coat; 4-12 mils DFT
   3. Base Coat (Modified Novolac Polyamine Epoxy Mortar)
      a. Tnemec Series 239SC Chembloc (with Part C Aggregate) MCK (Mortar Containment Kit); 1 coat; 60-80 mils DFT
   4. Reinforcement:
      a. Tnemec Series S211-0215; ¾ ounce chopped strand fiberglass mat embedded into the Series 239SC Epoxy Mortar base coat
   5. Saturant Coat (Modified Novolac Polyamine Epoxy)
      a. Tnemec Series 239SC Chembloc RCK; 1 coat; 8-12 mils DFT
   6. Finish Coats (Polyamine Novolac Epoxy)
      a. Tnemec Series 282 Tnemec-Glaze; 2 coats; 4-8 mils DFT per coat (vertical); 6-12 mils DFT per coat (horizontal)
   7. Finish Coating System: Total DFT: 100-125 mils
   8. Finish Coat: Aliphatic Polyester Polyurethane CRU (Chemical Resistant Urethane) UV Resistant
      a. Tnemec Series 290 CRU; 1 coat; 2-3 mils DFT (For exterior exposure (considered sacrificial); do not use in trenches, sumps or interior exposure.)

E. New and Existing Cast-In-Place Concrete associated with all Potable Water Containment Tanks, Reservoirs and Channels at Ambient Temperature; Intermittently Submerged and Submerged, Interior and Exterior:
   1. Provide all painting system components specified for all cast-in-place concrete surfaces including but not necessarily limited to, troughs, walls, beams, columns, undersides of walkways and other locations which may be shown on the Drawings.
   2. Surfacer/Filler (Epoxy Modified Cementitious Mortar)
      a. Coating 1. Tnemec Series 218 MortarClad; 1 parge coat trowel applied; nominal 1/16 inch minimum DFT (actual DFT to depend on the depth of the profile in the concrete after abrasive blasting.)
   3. Finish Coat (s) (100% Solids NSF Certified Polyamine Epoxy)
      a. Tnemec Series 22 or FC22 Epoxoline; 1 or more coats; 30-40 mils DFT

F. New and Existing Concrete Masonry Unit Walls; Non-submerged, Interior: (LEED Compliant through Version 3.0)
   1. Blockfiller (Inorganic Water Based Epoxy)
      a. Tnemec Series 1254 EpoxoBlock WB; 1 coat; 75-125 square foot per gallon
   2. Finish Coats (Polyamidoamine Epoxy)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 2 coats; 4-6 mils DFT per coat

G. New and Existing Exterior Cast-In-Place Concrete, Concrete Masonry Units and Wood; Above-Grade, Exterior:
   1. Primer (Waterborne Modified Polyamine Epoxy) (Cast-In-Place Concrete and Wood):
      a. Tnemec Series 151-1051 Elasto-Grip FC; 1 coat; 200-400 square foot per gallon
   2. Finish Coats (Styrenated Acrylate)
      a. Tnemec Series 156 Enviro-Crete; 2 Coats; 6-8 mils DFT per coat

H. New and Existing Ferrous Metals, Structural Steel (not protected by sprayed fireproofing), Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, Above ground Ductile-Iron Piping and Exterior Surfaces of all Ferrous Piping (both exposed and to be later covered with insulation); Non-submerged, Interior: (LEED Compliant through Version 3.0)
   1. Primer (Polyamidoamine Epoxy *)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
   2. Finish Coat (Polyamidoamine Epoxy)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

I. New and Existing Ferrous Metals, Non-Ferrous Metals, Fiberglass and Galvanized Metals; Non-Submerged, Exterior:
   1. Primer (Polyamidoamine Epoxy*)
      a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
   2. Intermediate Coat (Polyamidoamine Epoxy)
      a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
   3. Finish Coat (Aliphatic Acrylic Polyurethane with UV Absorbers)
      a. Tnemec Series 1075U Endura-Shield II; 1 coat; 2.5-3.5 mils DFT

J. New and Existing Galvanized Metal, Fiberglass and Non-Ferrous Metal; Non-submerged, Interior: (LEED Compliant through Version 3.0)

1. Primer (Polyamidoamine Epoxy*)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
2. Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

K. New and Existing Aluminum in Contact with Dissimilar Materials:
1. Primer (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
2. Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

L. New and Existing Pipe and Duct Insulation, Cloth, Paper and Canvas Jacketed; Non-submerged, Interior: (LEED Compliant through Version 3.0)
1. Prime Coat (Self-crosslinking Hydrophobic Acrylic)
   a. Tnemec Series 115 Uni-Bond DF; 1 coat; 2-4 mils DFT
2. Finish Coats (HDP Acrylic Polymer)
   a. Tnemec Series 1029 Enduratone; 2 coats; 2-3 mils DFT per coat

M. New and Existing PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior: (LEED Compliant through Version 3.0)
1. Prime Coat (Self-crosslinking Hydrophobic Acrylic)
   a. Tnemec Series 115 Uni-Bond DF; 1 coat; 2-4 mils DFT
2. Finish Coat: (HDP Acrylic Polymer)
   a. Tnemec Series 1029 Enduratone; 1 coat; 2-3 mils DFT

N. New and Existing Exterior Surfaces of Steel Pipe; Buried Exterior:
1. Primer (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 6-8 mils DFT
2. Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 6-8 mils DFT

O. New and Existing Gypsum Wallboard, Plaster and Wood; Interior: (LEED Compliant through Version 3.0)
1. Primer/Sealer (Vinyl Acrylic) (Gypsum Wallboard and Plaster)
   a. Tnemec 54 PVA Sealer; 1 coat; 1 mil DFT
2. Primer (Waterborne Modified Polyamine Epoxy) (Wood):
   a. Tnemec Series 151-1051 Elasto-Grip FC; 1 coat; 200-400 square foot per gallon
3. Finish Coats (HDP Acrylic Polymer)
   a. Tnemec Series 1029 Enduratone; 2 coats; 2-3 mils DFT per coat

P. Where it is determined that abrasive blasting surface preparation is not feasible use Tnemec Series 135 Chembuild as the prime coat.

2.3 SUBSTITUTIONS

A. No products that decrease the film thickness, the surface preparation, VOC's, solids by volume or the generic type of coating specified shall be considered. Approved manufacturers shall furnish the same color selection as the manufacturers specified, including accent colors and custom colors in all coating systems, and shall document

satisfactory performance of their coating system For at least three treatment plants that have been in service at least five years each.

2.4 PIPING MARKERS

A. General:
   1. For pipes over 3/4-inch outside diameter: Provide painted pipe markers.
   2. For pipes under 3/4-inch outside diameter: Provide aluminum tags, totally compatible with service conditions, 1-1/2-inch diameter, with depressed 1/4-inch high black filled letters Above 1/2-inch high black filled numbers.
   3. Each marker shall consist of at least one legend descriptive of the function of the pipe and a directional arrow.
   4. The size of lettering and marker shall conform to ANSI A13.1.
   5. Location of Markers:
      a. Adjacent to each valve and "T" connection.
      b. At each branch and riser takeoff.
      c. At each pipe passage through a wall, floor and ceiling.
      d. On all horizontal and vertical pipe runs at 25-foot intervals.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which painting Work is to be performed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film capable of performing in accordance with claims made in manufacturer's product literature for the surfaces and conditions encountered. Do not paint over “UL” or similar labels, including mechanical and electrical Manufacturer nameplates.

C. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for the long-term adherence and durability of painting systems specified or where the manufacturer requires removal of all existing paint in order to recommend the use of the specified painting system.

D. Provide lighting for all work areas to be inspected as prescribed in SSPC Guide 12. No coating inspections will be conducted until the minimum lighting requirements for inspection is provided.

E. Assure that all surfaces and areas to be inspected will be clean and ready for inspection so the coating and/or lining system can be immediately applied. No inspections will be conducted if areas and/or surfaces have dust and debris floating in the air and/or covering the substrates to be inspected.

F. All expenses due to delays, extra coating inspections etc is the sole responsibly of the CONTRACTOR

3.2 SURFACE PREPARATION

A. General:
   1. Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.
   2. Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested according to ASTM D 4285. Test air quality at each startup, but in no case less often than every five operating hours.
   3. Provide lighting for all work areas as prescribed in SSPC Guide 12.
   4. Prior to performing any testing, i.e soluble salts, adhesion, moisture content or vapor, alkalinity etc all principle parties shall agree upon in writing methods of testing, quantity of testing, acceptable results, and the proper course of action that will be taken in case the acceptable limits are not or cannot be met. Excessive moisture, or other conditions, may impact the Project Schedule.
   5. Prior to any surface preparation covered in this section, all surfaces should meet the acceptable conditions required.
      a. Inspect all surfaces for oil and/or grease contamination using two or more of the following inspection techniques. Reject oil and/or grease contaminated surfaces, clean using a water based pH neutral degreaser in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.
         1) Visual Inspection
         2) Water Break Test
         3) Black Light Test
         4) Cloth Rub Test
      b. Water Break Test - Spray atomized mist of distilled water onto surface, and observe for water beading. If water "wets" surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.
      c. Black Light Test - Inspect surfaces for oil and grease contamination using the light specified in the paragraph Black Light. Use light no more than 12 inches from surface unless testing indicates that the specific oil or grease found in tank fluoresce at a greater distance. Use light in tank that is completely sealed from light infiltration, under a hood, or at night. Any fluorescing on steel surfaces is an indication of petroleum oil/grease contamination. Use either Water Break Test or Cloth Rub Test to confirm both contaminated and non-contaminated areas detected by Black Light Test. The Black Light Test may not be used during inspection of prepared surfaces for oil and grease contamination unless proven to fluoresce the oil and/or grease found in the specific tank and documented during testing prior to abrasive blasting. Generally, only petroleum oil/grease will fluoresce, however, some may not fluoresce sufficiently to be recognized and other methods, such as the Water Break Test or Cloth Rub Test, must be used to confirm findings of the Black Light Test.

d. Cloth Rub Test - Rub a clean, white, lint free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

6. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items already in-place and that does not require field painting, or provide effective surface-applied protection prior to surface preparation and painting operations.
7. Remove, as necessary, items, which must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved. Surfaces to be painted must be clean, dry and sound before applying any painting system components. Should any surface be found in an unsatisfactory condition, remediate by the best means feasible to provide a acceptable coating condition.
8. Coating products shall not be applied until the ENGINEER has inspected the materials and the coating manufacturer's technical representative has instructed CONTRACTOR and ENGINEER in the surface preparation, mixing and application of each coating.

B. Cast In Place Concrete. Precast Concrete and other Masonry Substrates
1. Test for moisture content of concrete surfaces before commencement of painting Work. There are many tests for moisture in concrete such as ASTM D 4263, ASTM F 1869 or ASTM F 2170. Provide from the submitted coating manufacturer in writing as to which standard they want used and what results must be obtained for satisfactory compliance. Report results to ENGINEER before starting Work.
2. Verify that the pH levels, of the cleaned concrete surfaces to be coated, are 10 to 12 or within the coating manufacturers' current written acceptable range. The pH of the concrete substrate will be measured using pH indicating papers. The pH testing is to be performed once every 50 square feet (5 square meters). Acceptable pH values can be measured using color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum). Use Hydrion Insta-Check Jumbo 1-12, or equal. The paper shall be touched to the surface once using moderate gloved finger pressure. The surface shall not be wiped or moved laterally to disturb the surface during pH testing. Following the one touch, lift the paper vertically to not "wipe" the surface. Compare the color indicated with the scale provided and record the pH. Spot check any areas that may be questionable with phenolphthalein solution. Where paint system is used to provide chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radius cove base fillets at all equipment pads and containment walls as part of the complete chemical containment paint system Work. Use materials and techniques recommended by the specified Manufacturer.
3. Remove all cast-in-place concrete fins, projections, tie wire, nails and other surface irregularities, which would protrude above the level of finished intermediate fillers and surfacers by chipping and scarification by mechanical abrasion.
4. Using specified filler and surfacer, patch all cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions and grind filler and surfacing compounds smooth and level with adjacent surfaces.

5. Where concrete masonry unit block filler is specified, spot patch holes and cracks with a putty knife using specified block filler to provide smooth finish for large surfaces coating materials can be applied by airless spray and backroll uniformly using a roller with a synthetic nap cover. While the coating material; is still wet a rubber squeegee can be used to provide a smooth finish.

C. Ferrous Metals:
1. Test surfaces for soluble salts, and wash as required, prior to any surface preparation. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require the removal of any barrier to the steel surface, including rust. This procedure may require combinations of wet abrasive blasting, high pressure water washing, and cleaning using a solution of water washing and soluble salts remover. The soluble salts remover shall be a acidic, biodegradable, nontoxic, noncorrosive, and after application, will not interfere with primer adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use clean potable water, or clean potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.
2. Verify that coating manufacturer recommended anchor profiles have been achieved on prepared surfaces using the submitted coatings current guidelines for its intended service environment. Report profiles to ENGINEER using Test Method B or C in compliance with ASTM D 4417.
3. All surface imperfections (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, and slivers) existing or new shall be removed from submerged or non-submerged ferrous metal surfaces. All edges and corners shall be ground to provide a smooth 1/16” radius. New ferrous metal surface imperfections are the responsibility of the manufacturer. Acceptance of the substrate without having these imperfections being corrected becomes the sole responsibility of the CONTRACTOR. Surface imperfections of previously coated ferrous metal surfaces that are being re-coated are the responsibility of the CONTRACTOR to remove or have re-moved.
4. Submerged or non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed shall be prepared according to the coating manufacturers current written guidelines for the submitted coating system and its intended service environment.
5. All shop primed items shall be inspected in the shop by an independent NACE CCI. Any shop applied coated pieces that do not or cannot provide documents for Q/C inspection will be re-prepared and re-coated in the field. The shop coating applicator will be solely responsibility for all financial burdens associated with this remediation.
6. Touchup shop applied prime coats which have damaged or have bare areas, according to SSPC-SP11, (Power Tool Cleaning to Bare Metal) at the time of painting system application, SSPC VIS 3 can be used as a comparison, Tightly adhering coating surrounding the bare metal shall be feather edged a minimum of 1 inch back to provide a clean, dry, sound and smooth transition from bare metal to remaining coating.
7. Remove all surface imperfections (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, slivers) using SSPC-SP2 (Hand Tool Cleaning) and/or SSPC-SP3 (Power Tool Cleaning) before full surface preparation operations begin.

8. Remove all rust and contamination on existing ferrous metals to sound surfaces by power tool cleaning complying with SSPC SP11 to provide a surface profile of not less than one mil.
9. Non-Ferrous Metal Surfaces: Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.

D. Galvanized (Zinc-Coated) Surfaces: Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.

E. CPVC Piping and Fiberglass: Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.

F. Covering on Pipe Insulation:
1. Remove all oil and surface contaminants as recommended by manufacturer for surface and application required.
2. Do not cut or damage the insulation in any way.

G. Gypsum Wallboard and Plaster:
1. Patch, sand and seal all rough spots before apply prime coat. Remove all dust and other contaminants prior to painting.
2. Touch-up all suction spots and hot spots with primer before application of finish coats.

H. Wood:
1. Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.
2. Prime, stain, or seal wood required to be site painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling and similar items.
3. Back prime paneling or interior partitions only where masonry, plaster, or other wet wall construction occurs on backside.
4. Seal tops, bottoms and cutouts of wood doors with a heavy coat of sealer as recommended by the door manufacturer immediately upon delivery to site.
5. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of the priming coat.
6. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler as recommended by manufacturer, sandpaper smooth when dried and dust off.

3.3 MATERIALS PREPARATION

A. General:
1. Mix and prepare painting materials in strict accordance with the coating manufacturer's current product literature.
2. Only use coating materials of the submitted coating manufacturer. Do not mix any painting materials produced by different manufacturers.

3. Only use thinners when required in the Work and that are provided by the coating manufacturer for the submitted coating system. Do not use any thinners not documented on its current product data sheet or outside its recommended guidelines.
4. Any deviation of mixing procedures must be approved in writing by the ENGINEER before any procedural change will be allowed.

B. Tinting:
1. Tint each undercoat a lighter shade to facilitate identification of each coat of multiple coat coating and/or lining systems.
2. Tint undercoats to match the color of the finish coat of paint, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide a code number to identify material tinted by the manufacturer.

C. Mixing:
1. For those products requiring constant agitation, use methods in compliance with manufacturer's product literature, to prevent settling during paint application.
2. Mix only in containers placed in suitably sized nonferrous or oxide resistant metal pans to protect concrete floors from splashes or spills. Provide for cleanup and for any damage associated from splash and/or spills.
3. Mix and apply paint only in containers bearing accurate product name of material being mixed, or applied.
4. Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film, which may form on the surface into the material. Remove the film and, if necessary, strain the material before using.
5. Strain products requiring such mixing procedures. After adjusting mixer speed to break up lumps and after components are thoroughly blended, strain through 35 to 50 mesh screen before application.

3.4 GENERAL APPLICATION REQUIREMENTS

A. General:
1. Thin, mix and apply coatings by brush, roller, or spray in strict accordance with manufacturer’s installation instructions.
   a. Application equipment must be inspected and approved in writing by coating manufacturer.
2. Temperature and weather conditions:
   a. Do not paint surfaces when surface temperature is below 50F unless product has been formulated specifically for low temperature application or approved in writing by Engineer and paint manufacturer's authorized representative.
   b. Air and Surface Temperatures: Prepare surfaces, then apply and cure coatings within air and surface temperatures minimum and maximum range according to the Manufacturer’s current instructions.
   c. Avoid painting surfaces exposed to hot sun.
   d. Do not paint on damp surfaces.
3. Immediately after any surface has been inspected and accepted, coatings must be applied, i.e. concrete, structural steel and miscellaneous steel prime coat.
   a. Finish coats shall be applied in the field.

b. Prime coat referred to here is prime coat as indicated in this Specification. Structural and miscellaneous steel prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.

4. Provide complete coverage to dry film thickness range specified.
   a. All paint systems are "to cover." In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
6. Use alternating colors to separate and distinguish the applied coatings.
7. Apply materials under adequate illumination as required under SSPC-Guide 12 Guide for Illumination of Industrial Painting Projects
8. Evenly spread to provide full, smooth coverage. All paint is to be applied in a continuous, monolithic and pinhole free manner.
9. Stripe coat (each coat) with a brush prior before full application. Stripe coats should be applied to edges, corners, crevices, joints, and other difficult to work areas.
10. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contaminate
    a. Clean contaminated surfaces before applying next coat
    b. Final coat shall be contaminate free. Remediated areas shall have the same color and gloss appearance as the surrounding painted area. A patchy appearance is not acceptable. Re-coat until appearance is acceptable by the ENGINEER at no additional cost to the owner.
11. Smooth out runs or sags immediately, or remove and re-coat entire surface.
12. Allow preceding coats to dry before recoating.
    a. Re-coat within time limits specified by coating manufacturer.
    b. If re-coat time limits have expired re-prepare surface according to the coating manufacturer’s current printed recommendations.
13. Allow coated surfaces to cure according to coating manufacturers written recommendations prior to allowing traffic or other work to proceed.
14. Coat all aluminum in contact with dissimilar materials.
15. When coating rough surfaces which cannot be back rolled sufficiently, hand brush coating to work into all recesses.
16. Spray, backroll, spray concrete surfaces if paint coatings are spray applied.

B. Prime Coat Application:
   1. Prime all surfaces indicated to be painted. Apply prime coat according coating manufacturer's written instructions.
   2. Ensure new coatings applied over existing coatings are compatible.
      a. Employ services of qualified independent NACE CCI or a coating manufacturer's qualified technical representative
         1) Certify thru material data sheets.
         2) Perform test patch.
         3) Provide written documentation of acceptance or non-acceptance of adhesion and compatibility.
      b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be

used as barrier coat, thickness to be applied, surface preparation and method of application.

c. At Contractor's option, coatings may be removed, surface re-prepared and new coating applied using appropriate paint system.

3. All damage to surface as result of coating removal shall be repaired to original condition or better at no additional cost to OWNER.
4. Prepare and prime ferrous metals embedded in concrete to minimum of 1inch below exposed surfaces in accordance with coating manufacturers recommendations.
5. Apply zinc-rich primers while under continuous agitation.
6. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.
7. All abrasive shall be vacuumed cleaned or swept and vacuum cleaned.
8. Brush or spray bolts, welds, edges crevices corners, edges and other difficult access areas with primer prior to primer application over entire surface.
9. Touch up damaged primer coats prior to applying finish coats. Restore primed surface equal to surface before damage.

C. Finish Coat Application:
1. Apply finish coats according to coating manufacturer's written instructions.
2. Touch up damaged finish coats using same application method and same material specified for finish coat. Prepare damaged area in accordance with Article 3.4.

3.5 REPAIRS

A. All repairs and corrective work will be done according to the coating manufacturers provide written recommendations. No repairs will be completed without the coating manufacturers written recommendations.

3.6 FIELD QUALITY CONTROL

A. Prior to initiating painting Work (if required), perform adhesion tests on existing coated surfaces, bare concrete substrates or newly/existing patched concrete to be painted. The following test methods are suggested.
1. ASTM D4541 - Pull-Off Strength of Coatings Using Portable AdhesionTesters
2. ASTM D7234 - Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
3. ASTM C1583/C1583M - Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

B. Consult with the coating manufacturer to determine if these or other methods are acceptable. Provide written test methods and qualifications for acceptance to ENGINEER. The number and location of tests shall be sufficient for CONTRACTOR to determine the condition of existing coatings and the suitability of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER a copy of adhesion test results.

C. Painting Records:
1. Maintain permanent written records of daily Q/C responsibilities.

2. Verify and record that the coatings and other materials are as specified (i.e., manufacturer, product name & product batch dates).
3. Verify and record condition of coatings and material along with their storage procedures
4. Verify and record surface preparation and application of coatings are as specified.
5. Verify and record coating mixing and thinning procedures, i.e. batch dates, amount mixed, material temperatures, induction time etc.
6. Verify and record application procedures.
7. Verify and record environmental conditions one half hour before work starting, then every 2 hours afterwards and once upon completion of work that day. Environmental readings must be obtained in the area that the work is taken place. Environmental readings shall not be obtained from computers, TV or cell phone apps. Readings shall be immediately taken should a sudden change in the climate be observed. Record results using sample forms or similar approved forms.
8. Verify and record WFT and DFT of each coat of the coating system are as specified using new wet film gauges and certified dry film thickness gauges. Dry film thickness readings shall be done according to SSPC-PA 2 (Level 3)

D. Independent NACE Third Party Inspection Responsibilities (Full Time):
1. Maintain permanent written records of daily Q/C responsibilities.
2. Verify and record that the coatings and other materials are as specified (i.e., manufacturer, product name & product batch dates).
3. Verify and record condition of coatings and material along with their storage procedures.
4. Verify and record environmental conditions one half hour before work starting, then every 2 hours afterwards and once upon completion of work that day. Environmental readings must be obtained in the area that the work is taken place. Readings shall not be obtained from computers, TV or cell phone apps. Environmental readings shall be immediately taken should a sudden change in the climate be observed. Record results using sample forms or similar approved forms.
5. Surface Preparation Inspection - Verify and record that the specified surface preparation meets or exceeds specified cleanliness standard and surface profile. Check for characteristics or defects that would adversely affect performance or appearance of coating systems.
6. Verify and record coating mixing and thinning procedures, i.e. batch dates, amount mixed, material temperatures, induction time etc.
7. Verify and record application procedures.
8. Coating Inspection - Verify and record the DFT readings of each coat. Check the applied coating film for characteristics or defects that would adversely affect performance or appearance of coating systems, i.e. runs, sags skippers, inconsistent / poor coverage.
9. Dry film thickness readings of ferrous and non-ferrous substrates shall be done in accordance with SSPC-PA 2 (Level 3).
10. Dry film thickness readings of concrete, wood, CPVC, drywall etc will be done according to agreed procedures of all parties.
11. Dry film thickness reading equipment to be used must be certified and still within certification during the inspection process.
    a. Ferrous and Non-Ferrous substrates - Type 1or Type 2 dry film thickness gauges, manufactured by Elcometer, Defelsko or equal.

b. Concrete, wood, CPVC, drywall - Defelsko Posi-Tector 200 using the correct probe for the substrate and thickness to be verified.

12. Check for discontinuities on concrete and/or steel immersion surfaces using holiday detector (NACE SP0-188). Any discontinuities located shall be corrected in according to with the coating manufacturer's most current written recommendations/guidelines. All corrected discontinuities shall be re-tested according to (NACE SP0-188) until compliant.

E. Verification/ Compliance of Inspection Instruments

1. Only use inspection equipment in good working order and has been certified by the equipment manufacturer on a yearly basis minimum. Certificates of calibration must be provided to the ENGINEER upon request.

3.7 PROTECTION

A. Provide "Wet Paint" signs as required to protect newly painted finishes. Protect surfaces of coating systems from damage from any possible surrounding activity.

B. Remove all temporary protective wrappings provided for protection of this Work and the work of other contractors after completion of painting operations.

3.8 ADJUSTMENT & CLEANUP

A. Correct all damages to the work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.

B. During the progress of the Work, remove from the site all discarded paint materials, rubbish, cans and rags at the end of each work day.

C. Upon completion of painting, clean all paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces. Any damage associated with the cleaning and removal process is the CONTRACTORS responsibility.

D. At the completion of Work of other trades, touchup and restore all damaged or defaced painted surfaces as determined by ENGINEER.

3.9 WARRANTY INSPECTION

A. The OWNER or OWNERS REPERSENTATIVE will conduct a warranty inspection during the eleventh (11th) month following completion of all coating work. All defective work shall be repaired by the CONTRACTOR in strict accordance with coating manufacturer's instructions, this Specification, and to satisfaction of OWNER and/or the OWNER'S REPRESENTATIVE.

B. Entire interior coating system shall be visually inspected. All defective coating, as well as damaged and rusting spots shall be satisfactorily repaired by and at no cost to the OWNER.

C. Coating Manufacturer's Representative: Shall be present, at no cost to the OWNER, during inspection of work to assist with assessment of condition of interior and exterior

coating and make recommendations for methods of repair of coating systems as may be required.

D. Inspection Report: Provide an inspection report covering first anniversary inspection, setting forth number and type of failures observed and percentage of surface area where failures have occurred.

E. Schedule: Upon completion of inspection and receipt of an Inspection Report as noted herein, The OWNER shall establish a date to proceed with remedial work. Any delay to meet schedule established by OWNER shall constitute breach of this Contract and the OWNER may proceed to have defects remedied, with costs involved paid by the CONTRACTOR.

F. Remedial Work: Any location where coating has peeled, bubbled, or cracked and any location where rusting is evident shall be considered to be a failure of coating system. CONTRACTOR shall make repairs at all points where failures are observed by removing deteriorated coating, cleaning surface, and recoating with same coating system. If area of failure exceeds twenty-five percent (25%) of total coated surface, entire coating system may be required to be removed and recoated in accordance with original Specification.

G. Costs: All costs for repair shall be borne by CONTRACTOR.

H. Repairs shall be warranted for an additional period of one (1) year.

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SAMPLE DAILY LOG

Engineer:	**GC:**	**Paint Contractor:**
Eng Contact:	**GC Contact:**	**Supervisor:**
Structure Description:		**Date:**
Specification:	**Project:**	

Hold Point/Inspection Item	**Performed by Contractor's QC**			**Status**		**Action Taken to Resolve UNSAT Conditions**
	YES	**NO**	**N/A**	**SAT**	**UNSAT**	
Adequate access & lighting provided						
Protective coverings in place						
SP-1 performed and grease, oil, & contamination removed						
Sharp edges, fins, slivers removed						
Removal of pack rust						
Ambient conditions						
Nozzle pressure						
Compressed air cleanliness						
Abrasive type & cleanliness						
Surface cleanliness						
Surface profile						
Soluble salt testing						
Soluble salt remediation						

Hold Point/Inspection Item	Performed by Contractor's QC			Status		Action Needed to Resolve UNSAT Conditions
	YES	NO	N/A	SAT	UNSAT	
Coating mixing						
Coating application						
Intercoat cleanliness achieved						
Recoat times observed						
Stripe coat applied						
Caulking applied						
Wet film thickness measurements						
Dry film thickness measurements						
Visual appearance						
Repairs to damaged coatings performed						

Ambient Conditions								
Location	Time	RH%	Air Temp	Surface Temp	Dew Point	Surface / Dew Pt +/-	SAT	UNSAT

QC Testing Performed	N/A	N/P	Location(s)	Specified	Actual	SAT	UNSAT
Compressed Air Cleanliness							
Surface Preparation (Cleanliness)							
Surface Profile							
Soluble Salt Contamination SCAT Chlor*Test Brescle Kitagawa Quantab Other:							
Wet Film Thickness							
Dry Film Thickness							

Coating Materials									
				Component A		Component B		Thinner	
Coating Type	Location Applied	Mix No.	Qty Mixed	Expiration Date (Shelf Life)	Batch No.	Expiration Date (Shelf Life)	Batch No.	Type/Name	Batch No.

Coating Material & Mixing Data										
Mix No.	% Thinner Added		Time of Mix	Mixed Coating Temp	Induction Time (SP)	Pot Life (SP)	Mix		Time from surface preparation/ previous coat to application	Coating Start/Stop Time
	Spec	Actual					SAT	UNSAT		

++ END OF SECTION ++

SECTION 09 93 15

POLYURETHANE COATING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish all labor, tools, equipment and materials to prepare surfaces, apply, and test a polyurethane pipeline coating system for steel pipe and fittings.

B. Except as described in this Section, the coating system shall be in accordance with AWWA C222 for straight pipe sections and fittings, specials, and field joints.

C. Materials shall comply with the requirements of the Safe Drinking Water Act and other federal regulations for potable water, wastewater, and reclaimed water systems as applicable.

1.2 REFERENCE STANDARDS

A. General: The latest revision of the following minimum standards shall apply to the coating materials, testing, and installation except where standards that are more stringent are applicable.

B. American Water Works Association (AWWA):
   1. AWWA C222 - Polyurethane Coatings for Interior and Exterior of Steel Water Pipe and Fittings.

C. ASTM International (ASTM):
   1. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   2. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

D. National Association of Corrosion Engineers (NACE):
   1. Recommended Practice RP-274 - High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.

E. Society for Protective Coatings, formerly Steel Structures Painting Council (SSPC):
   1. SSPC-SP-1 Solvent Cleaning Surface Preparation.
   2. SSPC-SP-2 Hand Tool Cleaning Surface Preparation.
   3. SSPC-SP-3 Power Tool Cleaning Surface Preparation.
   4. SSPC-SP-6 Commercial Abrasive Blast Surface Preparation.
   5. SSPC-SP-10 Near White Metal Abrasive Blast Surface Preparation.

1.3 DEFINITIONS

A. Manufacturer: The party that manufactures the coating material described in this Section.

B. Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.

C. Day: A day is defined as a 24-hr period.

1.4 ABBREVIATIONS

A. ANSI: American National Standards Institute

B. AWWA: American Water Works Association

C. MDFT: Minimum Dry Film Thickness

D. Mil: Thousandths of an Inch

E. OSHA: Occupational Safety and Health Act

F. SSPC: Society for Protective Coatings (Steel Structures Painting Council)

1.5 SUBMITTALS

A. General:
1. Submittals shall be made in accordance with the General and Special Conditions.
2. Catalog cuts and other manufacturer's information shall be submitted for all materials provided on a system-by-system basis.
3. Provide copies of paint system submittals to the coating applicator.
4. Indiscriminate submittal of manufacturer's literature only is not acceptable.

B. Coating Systems Data Sheets:
1. For each paint system, furnish a Material Safety Data Sheet (MSDS), the manufacturer's technical data sheets, and paint colors available (where applicable) for each product used in paint system.
2. Technical and performance information that demonstrate compliance with Specification.

1.6 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification: Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. The coating manufacturer’s technical representative shall provide a qualified technical representative, employed by the coating manufacturer, in the field for 1 day, minimum, at the start of coating application. During this visit, the manufacturer’s representative shall conduct inspections as required to ensure that coating application is in conformance with their recommended methods and conditions.

C. Additional visits by the manufacturer’s representative shall be made at sufficient intervals during surface preparation and coating application as may be required for product application quality assurance, and to determine compliance with

manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this Project.

1.7 OBSERVATION OF WORK

A. Give the Engineer a minimum of 7 days' advance notice of the start of any Work to allow scheduling for shop observation.

B. Provisions shall be made to allow Engineer's representative full access to the Work and appropriate documentation regarding coating application.

C. Materials shall be subject to observation for suitability as the Engineer may elect, prior to or during incorporation into the Work, including compliance with proper storage of materials and with material expiration dates.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Pipe shall be handled in accordance with AWWA C222 and in such a manner as to protect the pipe and coating from damage.

B. Coated pipe shall not be installed until the coating has developed full adhesion and cure.

C. During coating application, storage, loading, transportation, unloading, laying and installation, every precaution shall be taken to protect and prevent damage to pipe and coating. Lift pipe using slings placed at quarter points along the pipe. Lift pipe with web slings a minimum of 18 inches wide and of a type that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.

D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. All pipe contact locations shall be heavily padded with carpet during shipment to the Project Site and from the storage yard to the point of installation.

E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at all contact points.

F. Pipe shall be inspected by the Contractor at the Project Site for damage. Any damage to the pipe or coating shall be repaired as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense to the Contractor.

G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk

on the coating except when absolutely necessary and approved by the Engineer. When permitted, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

PART 2 - PRODUCTS

2.1 GENERAL

A. Coatings shall be stored, handled, and applied per the manufacturer's written directions. Exterior pipe surfaces shall be cleaned and coated in accordance with referenced AWWA Standards, written directions of the coating manufacturer, and these Specifications, whichever is more stringent. Other surfaces to be coated shall be prepared as required for steel pipe, as applicable.

B. Polyurethane coating shall be the product of a single manufacturer. Substitutions will not be permitted.

2.2 EXTERIOR SHOP-APPLIED COATINGS

A. Plural Component Polyurethane:
   1. Polyurethane coating system shall consist of an ASTM D16 Type V thermoset, aromatic polyurethane plastic polymer that is the reaction product of diphenylmethane diisocyanate (MDI) resin and polyol resin or polyamine resin or a mixture of polyol and polyamine resins (referred to hereafter as polyurethane system). The polyurethane system shall meet the performance requirements as specified in AWWA C222.4.2 and shall be applied in accordance with AWWA C222, except as modified herein.
   2. Coating: Self-priming, plural component, 100 percent solids, polyurethane, suitable for burial or immersion, and shall be the product of one of the following approved manufacturers:
      a. Futura Coatings (Protec II), Hazelwood, Missouri
      b. Engineer-approved equal

   3. Coating Thickness:
      a. The minimum applied dry film thickness of the exterior polyurethane system shall be 30 mil or the minimum dry film thickness required by the manufacturer to meet the requirements of AWWA C222, whichever is greater.
      b. The polyurethane system may be applied to any maximum dry film thickness as recommended by the manufacturer. When applied at the maximum dry film thickness, the coating system shall pass all performance requirements as specified in AWWA C222.4.2.
      c. The dry film thickness of the coating shall be measured in accordance with SSPC-PA 2. The averages listed in SSPC-PA 2 shall be deleted, and no single gauge reading shall be less than the specified minimum thickness.

2.3 FIELD EXTERIOR JOINT COATING

A. Pipe joints shall be field coated with heat-shrink sleeves after pipe assembly as specified in Section 40 46 16.

2.4 FIELD REPAIR OF COATINGS

A. General: Field coating shall be compatible with the shop-applied coating system or shall be provided by the same manufacturer.

B. Polyurethane Coating:
   1. Polyurethane coating system repair shall be in accordance with the coating manufacturer's recommended procedures.
   2. Coating material for repairs greater than 6 inches diameter shall be the same as the existing coating, or for repairs less than 6 inches diameter, repair coating as recommended by the polyurethane coating manufacturer, subject to Engineer approval. Repair coating shall have adhesion and performance characteristics equal to the existing coating.

PART 3 - EXECUTION

3.1 GENERAL

A. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.

3.2 ENVIRONMENTAL CONTROLS

A. General:
   1. Provide heating, cooling, or dehumidification equipment as required to meet the surface preparation and coating application environmental requirements as specified and recommended by the coating manufacturer.
   2. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
   3. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
   4. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent or whenever the steel pipe surface temperature is less than 5 degrees F above the dew point of the ambient air.
   5. Do not apply coatings when:
      a. Surface and ambient temperatures exceeds the maximum or minimum temperatures recommended by the paint manufacturer or these Specifications,
      b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
   6. Where weather conditions or Project requirements dictate, provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturer's coating application recommendations.

B. Temperature Control:
   1. When temperatures are above or below the coating manufacturer's recommended application temperatures, provide temperature controls to permit Work to proceed within the temperature limitations of the Project.
   2. Heating shall be with indirect fired heaters that do not increase humidity levels within the Work area. Heaters shall be sized for the area to be heated.
   3. The steel surface may be heated to a temperature within the manufacturer's recommended limits without contaminating the surface preparation in any way.
   4. Preheated coating material components, in-line heaters, heated hoses, or other methods may be used to facilitate the application of the coating. Heating shall conform to the recommendations of the coating manufacturer.
   5. Provide tenting, baffles, or bulkheads as required to zone and control the heating or cooling effectiveness.

3.3 SHOP-APPLIED COATING SYSTEM

A. General:
   1. Applicator Qualifications:
      a. Equipment will be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.
      b. Equipment not meeting the written requirements of the coating manufacturer shall be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the Engineer.
      c. All personnel applying the coating system shall provide certification of attendance at the coating manufacturer's training class within the last 3 years.
   2. Coating manufacturer shall provide to the Engineer a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application. Strict conformance to the requirements of the manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating. Rejected coating shall be removed to bare metal and reapplied using proper application methods in accordance with the quality assurance manual and the requirements of these Specifications.
   3. Coating applied under improper environmental conditions will be rejected and shall be removed to bare metal and reapplied under proper environmental conditions.
   4. Pipes and other items that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected and the coating removed to bare metal and recoated.

B. Weld Surface Preparation:
   1. Welds shall be ground to a tolerance of plus 1/32 inch to plus 1/64 inch above the pipe surface to be coated.

C. Surface Preparation:
   1. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.

2. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.
3. In cold weather or when moisture collects on the pipe and the temperature of the pipe is less than 45 degrees F, preheat pipe to a temperature above 50 degrees F and 5 degrees F above dew point.
4. Pipe shall be cleaned by abrasive blasting with a mixture of steel grit and shot to produce the surface preparation cleanliness as specified. Recycled abrasive shall be cleaned of debris and spent abrasive.
5. Protect prepared pipe from humidity, moisture, and rain. Keep pipe clean, dry, and free of flash rust. All flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by reblasting prior to primer application.
6. Coating of pipe shall be completed the same day as surface preparation.
7. Surface Preparation: SSPC-SP10, Near White Metal blast, 3.0 mil profile, minimum, or as required by the manufacturer, whichever is greater.

D. Polyurethane Coating Application:
1. Pipe temperature shall be between 75 and 100 degrees F and 5 degrees F above dew point during coating application. Coating application shall be performed in an environmentally controlled area that meets or exceeds the written environmental application requirements of the coating manufacturer.
2. Thickness: One coat, 30 mils total dry film thickness, minimum. Additional thickness may be required to pass the holiday and coating defects limitations as specified in this section.
3. Coating adhesion and holiday testing shall be tested as specified this section.
4. Complete coating repairs as specified this section.

E. Holdbacks and Cutbacks:
1. 6 inches, minimum.
2. Coating cutbacks or holdbacks shall be made straight and cut through the full thickness of the coating. Cutbacks shall be completed in a manner that permits field coating of joints in accordance with the manufacturer’s recommendations and as specified herein.

F. Coating Special Pipe Connections and Appurtenances
1. Prior to shipping, threaded connections and appurtenances that must be assembled and operated in the field shall be left uncoated and shipped with rust-preventing compounds or strippable protective coatings applied to the threads only. After final field assembly, the compound shall be completely removed. The exposed threads shall be coated per AWWA C222.4.7.

3.4 FIELD COATING OF JOINTS

A. Coat joints with heat-shrinkable sleeves as specified in Section 40 46 16

3.5 FIELD REPAIR OF COATING

A. General:

1. All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired.
2. Clean area to be repaired for a minimum distance of 6 inches in all directions from the damaged area by solvent wiping.

B. Polyurethane Coating Repairs:
1. Shop and field coating repairs shall be completed in accordance with the manufacturer's written instructions and these Specifications, whichever is stricter.
2. Coating repairs on any joint of pipe shall not exceed an average of 2 per 100 square feet of surface area per joint of pipe or an individual defect greater than 6 inches in diameter. Holidays within a 4 inch radius of a holiday shall be counted as a single holiday.
3. Pipes exceeding the maximum number or size of coating defects shall be blasted to bare metal and recoated.
4. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor’s expense.
5. Surface defects that do not expose the metal substrate shall be repaired by power tool sanding with coarse sandpaper to roughen the coating surface and feathering the edges of the defect for a minimum of 3 inches around the defect. Apply a single coat of the specified patch coating material to a properly prepared surface at the specified coating thickness.
6. Deep defects, defined as defects which penetrate to the metal substrate or expose the metal substrate, shall be prepared to the metal substrate by power tool sanding to expose the metal and feather the coating edges a minimum of 6 inches. The metal surface and surrounding coating shall be reblasted to equal cleanliness and profile as the original surface preparation. Existing coating shall be roughened to the equivalent of coarse sandpaper by abrasive blasting. One coat of the specified coating material shall be applied over the repaired surface at the specified thickness.

3.6 INSPECTION AND TESTING

A. General:
1. Applicator shall conduct quality control inspection and testing of the applied coatings in accordance with AWWA C222 specifications and these Specifications. The frequency of testing and inspections shall be determined by the applicator.
2. Manufacturer and applicator shall conduct quality assurance inspection and testing as defined herein and as required by AWWA C222 for final acceptance of the pipeline coating. Manufacturer’s certified test reports and applicator quality control testing will be the basis for product acceptance. The Owner and/or Engineer reserves the right to perform additional quality control testing in the determination of product acceptance. Coating repairs for quality assurance testing shall be repaired by the applicator as specified herein.

B. Adhesion Testing:
   1. General
      a. Provide a minimum of four adhesion tests on four separate pipe joints.
      b. The pipe coating applicator shall repair all coating damage from adhesion testing.
      c. Adhesion tests will be performed not less than 24 hours after coating application.
      d. Pipe joints will be randomly selected for adhesion testing. If any one of the pipe joints tested fails the adhesion test, each pipe joint will then be individually tested for adhesion and rejected on a joint-by-joint basis.
   2. Polyurethane Adhesion Testing:
      a. Polyurethane coatings shall have an adhesion to steel of 1,500 pounds per square inch, minimum.
      b. Polyurethane coating adhesion to steel substrates shall be tested using pneumatic pull off equipment, such as HATE equipment or equal, in accordance with ASTM D4541 and AWWA C222, except as modified in this section.
      c. Dollies for adhesion testing shall be glued to the coating surface and permitted to cure for a minimum of 12 hours. Coating shall be scored around the dolly prior to conducting the adhesion test. Dollies shall be concave or convex to fit the pipe surface on any pipe less than 30 inches in diameter.
      d. Failure shall be by adhesive failure only. Adhesive failure is defined as separation of the coating from the steel substrate. Glue failures in excess of the minimum required tensile adhesion would be accepted as meeting the specified adhesion requirements.
      e. Repair patches on the polyurethane coating shall be randomly selected for adhesion testing in a manner as described herein and at the discretion of the person conducting the adhesion tests. Inter-coat adhesion of repairs shall be not less than 50 percent of the specified polyurethane coating adhesion requirements to steel.
   3. Holiday Testing:
      a. Polyurethane Coatings:
         1) Holiday tests will be conducted on the completed coating after a minimum of 1-hour cure using a high voltage spark test in accordance with NACE Standard RP-274 and these Specifications.
         2) Holiday testing shall be performed at a voltage of 100 volts per mil of the minimum specified (not the average) coating thickness.
         3) Coating thickness will be determined by dry film thickness testing and the average coating thickness used for holiday testing.
      b. Joint Coatings: As specified in Section 40 46 16.
   4. Dry Film Thickness Testing: Coatings shall be tested for dry film thickness in accordance with SSPC PA-2 using a properly calibrated magnetic pull off or eddy current equipment.

+ + END OF SECTION + +

SECTION 09 96 16

REINFORCED NOVOLAC EPOXY RESIN TOPPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish, install and place into satisfactory service all sulfuric acid-resistant monolithic lining. The Work also includes:
      a. Providing openings in the reinforced Novolac epoxy resin topping corrosion protection system to accommodate the Work under this and other Sections, and building into the reinforced Novolac epoxy resin topping corrosion protection system all items such as sleeves, anchor bolts, inserts and all other items to be embedded in, or inserted through, the reinforced Novolac epoxy resin topping corrosion protection system for which placement is not specifically provided under other Sections.
      b. All systems shall include scarification, acid etching and other substrate preparations, bond coats, reinforcements, underlayment fills, moisture barrier coatings, binder coats, top coats, sealants and other components and system accessories recommended by the manufacturer for cast-in-place concrete floor slabs, curbs, equipment pads, tops and sides of containment walls, trenches, steps sumps, equipment pits and similar cast-in-place concrete items, described in Part 2, below.
      c. Provide a reinforced Novolac epoxy resin topping corrosion protection system at the chemical storage facilities in the chemical storage areas, as shown on the Drawings.
      d. Include manufacturer's recommended details for conditions encountered in the Work and a Field Quality Control Report, including procedures, test methods, results of tests, remedial recommendations and actions.
      e. Provide complete technical services, as available from the manufacturer, and on-site technical representation by manufacturer's technical representative during the time of material delivery, storage, mock-up, substrate preparation and the advancement of installation to thirty percent of floor areas receiving concrete reinforced Novolac epoxy resin topping corrosion protection systems and during the start of field quality control testing
   2. Extent of the reinforced Novolac epoxy resin topping corrosion protection system is shown on the Drawings and, in addition, includes the following:
      a. Unloading Area:
         1) Driveway.
      b. Bottoms and sides of all trench drains, sumps and horizontal pipe chases in chemical unloading area driveways.
   3. Types of products required include the following:
      a. The reinforced Novolac epoxy resin topping corrosion protection system shall be a three component, 100 percent solids, Novolac epoxy resin,

silica filled, protective and waterproofing lining with a heavy-duty reinforcement layer of woven roving fiberglass reinforcement. Concrete surface primer shall be a catalyzed epoxy resin containing conductive fillers, 100 percent solids content. Sealants are two component epoxy and two component polysulfide. Moisture barrier coating shall be two component polyurethane. Finish coats shall be a three component, 100 percent solids, Novolac epoxy resin.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the reinforced Novolac epoxy resin topping corrosion protection system.
   2. Coordinate and schedule preparation of substrates, before equipment and similar items are installed to avoid later difficulty, or delay, in performing the Work of this Section, and to provide substrates within tolerances and surface profile specified.
   3. Coordinate and schedule abrasive blasting of substrates to avoid later difficulty or delay in performing the Work.
   4. Coordinate the setting of drains and other items in compliance with the recommended details of the reinforced Novolac epoxy resin topping corrosion protection system for complete product responsibility.
   5. Coordinate installation of reinforced epoxy resin topping corrosion protection system on existing surfaces with OWNER'S maintenance and operations staff.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single installer, certified or licensed by the reinforced Novolac epoxy resin topping corrosion protection system manufacturer, regularly performing trowel-applied lining installation, and with documented skill and successful experience in the installation of the types of materials required; and who agrees to employee only tradesmen who are trained, skilled and have successful experience in installing the types of materials specified.
   2. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owners, architects or Engineer’s responsible for projects.
      b. Approximate contract cost of the reinforced Novolac epoxy resin topping corrosion protection system.
      c. Amount of area installed.
   3. Submit proof of acceptability of installer by manufacturer to ENGINEER.

B. Testing Agency Qualifications: To qualify for approval, an independent testing agency shall demonstrate to ENGINEER’S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E 329 and as documented according to ASTM E 548, without delaying the Work.

C. Source Quality Control:

1. Engage a single manufacturer who shall furnish the services of a technical representative to assist CONTRACTOR, ENGINEER and OWNER by providing technical opinions on the adequacy of materials and methods of installation and site quality control testing. The reinforced Novolac epoxy resin topping corrosion protection system manufacturer shall provide engineering field services to review the project and the material application prior to surface preparation: to approve the applicator, the materials used, and the procedure to be used; to provide the minimum pull-off adhesion strength, when testing for adhesion; to observe and approve surface preparation; and to observe application. The field representative of the reinforced Novolac epoxy resin topping corrosion protection system manufacturer shall submit, through CONTRACTOR, written approvals of the proposed protection system materials, application procedures, applicator, and surface preparation. The engineering field representative shall be an employee of the material manufacturer.
2. Furnish such services during the time of delivery, storage, mock-up installation, installation and on-site quality control testing of all reinforced Novolac epoxy resin topping corrosion protection system components.
3. Engage a manufacturer who will provide complete technical services including preparation and review of Shop Drawings, installation methods and proposed detailing.
4. Provide all components of the reinforced Novolac epoxy resin topping corrosion protection system produced by a single manufacturer, including recommended primers, base coat, woven roving fiberglass mat, sealants and topcoat materials.
5. Certify product shelf life history for each system component. Do not use resins and catalysts manufactured more than six months prior to the time they will be incorporated into the Work.
6. Certify that all reinforced Novolac epoxy resin topping corrosion protection system materials have been stored in full compliance with all storage recommendations of the reinforced Novolac epoxy resin topping corrosion protection system and that resins, catalysts and other sensitive auxiliary system components have been constantly stored between 50° and 75°F, and have not, nor will be, subjected to freezing temperatures.

D. Performance Criteria:
1. Manufacturers of "or equal" products shall provide direct property comparison with the materials specified in addition to complying with all other requirements of the Specifications. "Or equal" products shall employ the same generic materials and system components as the reinforced Novolac epoxy resin topping corrosion protection system specified.
2. CONTRACTOR'S Review: Submit to ENGINEER a written statement signed by CONTRACTOR, stating that the Contract Documents have been reviewed with the reinforced Novolac epoxy resin topping corrosion protection system manufacturer who confirms that, if properly installed, the specified system is capable of providing performance criteria specified, is appropriate for installation shown on the Drawings and that the details proposed for use in the Work are not in conflict with the manufacturer's details.
3. Statement of Application: Upon completion of the reinforced Novolac epoxy resin topping corrosion protection system Work, certify to ENGINEER and

OWNER that the Work complies with the requirements of this Section, was installed in compliance with manufacturer's written recommendations, and that the installation methods were proper and adequate for the conditions of installation and use.

E. Referenced Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. ASTM C 307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts and Monolithic Surfacings.
2. ASTM C 579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.
3. ASTM D 635, Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
4. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics.
5. ASTM D 2200, Pictorial Surface Preparation Standards for Painting Steel Surfaces.
6. ASTM D 4060, Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
7. ASTM D 4259, Practice for Abrading Concrete.
8. ASTM D 4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
9. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed Air.
10. ASTM D 4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
11. ASTM D 4541, Test Method for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
12. ASTM D 7234, – Standard Test Method for Pull-off Adhesion Strength of Coatings on Concrete Using Portable Pull-off Adhesion Testers.
13. ASTM D 4787, Practice for Continuity Verification of Liquid or Sheet Linings Applied To Concrete Substrates.
14. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
15. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
16. ASTM F 1869, Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
17. National Association of Corrosion Engineers (NACE), Essentials of Surface Preparation.
18. Steel Structures Painting Council, SSPC - Volume 2, Systems and Specifications.
19. Steel Structures Painting Council, SSPC - PA2, Measurement of Dry Coating Thickness with Magnetic Gages.
20. Steel Structures Painting Council, SSPC - VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.

F. Allowable Installation Tolerances:
1. Do not install Work until substrate preparation and tolerances have been approved by ENGINEER, the reinforced Novolac epoxy resin topping corrosion protection system manufacturer's technical representative and the reinforced Novolac epoxy resin topping corrosion protection system installer,

and CONTRACTOR has verified to ENGINEER, in writing, that substrates are within tolerances and profiles specified and acceptable to produce approved Work. Work advanced, for any reason, without such verification shall be stopped, and the reinforced Novolac epoxy resin topping corrosion protection system removed and replaced with new material if substrates are determined to be unacceptable for approved Work.

2. Substrate Tolerances:
   a. Out-of-Plane: 1/8-inch maximum in ten feet and 1/16-inch maximum in any 12-inches measured along the plane.
   b. Maximum Offset in Plane Alignment: 1/16-inch.
   c. Variation From Slope: 1/8-inch maximum in ten feet.
3. Reinforced Novolac Epoxy Resin Corrosion Protection System Tolerances:
   a. Finish reinforced Novolac epoxy resin topping corrosion protection systems level to 1/8-inch in ten feet with smooth continuous uniformly sloped-to-drain planes.
   b. Provide smooth continuous color with no color streaks or inconsistencies with smoothly textured non-slip finish.

G. Pre-Installation Meeting:
   1. Before erecting mock-ups, CONTRACTOR, installer, and technical representative of the reinforced Novolac epoxy resin topping corrosion protection system shall meet on-site with ENGINEER to discuss approved products and workmanship to ensure proper application of the reinforced Novolac epoxy resin topping corrosion protection system components and substrate preparation requirements.
   2. Review foreseeable methods and procedures related to the reinforced Novolac epoxy resin topping corrosion protection system Work, including, but not necessarily limited to, the following:
      a. Review Project requirements and the Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review status of substrate Work, including approval of surface preparations and similar considerations.
      d. Review requirements of on-site quality control testing and requirements for preparing quality control report as specified herein.
      e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
      f. Review required inspection, testing and certifying.
      g. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
      h. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
      i. Review procedures required for the protection of the reinforced Novolac epoxy resin topping corrosion protection system during the remainder of the construction period.
   3. Record the discussions of the Pre-Installation Meeting and the decisions and agreements or disagreements reached, and furnish a copy for the record to each party attending. Record any revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.
   4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

H. Mock-Ups:
1. Prior to the installation of the reinforced Novolac epoxy resin topping corrosion protection system and auxiliary system components, but after ENGINEER'S approval of samples and Shop Drawings, install eight foot square stepped-back mock-ups of the systems showing each system component, in areas selected by ENGINEER, to show representative installation of the Work. Include methods of installation typical to the Work, including penetrations and cove details, using all system components required for the Work.
2. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of reinforced Novolac epoxy resin topping corrosion protection system Work. Retain and protect mock-ups during construction as one standard for judging completed reinforced Novolac epoxy resin topping corrosion protection system Work. Do not alter mock-ups after approval by ENGINEER.
   a. Finished Work, in compliance with visual qualities of mock-ups, that fails other on-site quality control testing procedures shall be replaced by CONTRACTOR with new materials.
3. Reinforced Novolac epoxy resin topping corrosion protection system Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material.
4. Build as many mock-ups as required to achieve ENGINEER'S acceptance of the reinforced Novolac epoxy resin topping corrosion protection system.
5. Reinforced Novolac epoxy resin topping corrosion protection system Work that proceeds without approved mock-ups shall be stopped, and mock-ups prepared for approval.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Stepped-back reinforced Novolac epoxy resin topping corrosion protection system applied to a 12-inch by 12-inch by 2-inch concrete sample panel showing specified surface preparation of concrete, each showing original unprepared surface in addition to each component of the reinforced Novolac epoxy resin topping corrosion protection system. Prepare sample panels such that all system components are adequately exposed to view. Apply reinforced Novolac epoxy resin topping corrosion protection system to only one-half of the sample board, leaving the other half visible and with required substrate preparation.
2. Full selection of manufacturer’s standard and custom colors for selection by ENGINEER. ENGINEER will preliminarily select a maximum of four colors for consideration for use in the Work. Prepare 12-inch by 12-inch samples of each color. From these the ENGINEER will select a maximum of four colors to be used in the Work. ENGINEER will provide CONTRACTOR with locations of each color after this final selection. In addition to color, provide range of textures from smooth to heavily non-slip for selection for use on job mock-up panel.
3. Sample submittals will be reviewed for number of system components only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of specifications, technical information, installation instructions and general recommendations from the reinforced Novolac epoxy resin topping corrosion protection system manufacturer for topping required. Include requirements for environmental conditions and other conditions required for an acceptable installation, providing features and performance as stated in manufacturer's literature.
   2. Drawings showing extent of each component of each system used in the Work including all items receiving reinforced Novolac epoxy resin topping corrosion protection system such as equipment pads, curbs, sumps, pipe trenches and similar items and surfaces and all details required for the Work referencing required system components provided as samples to ENGINEER. Provide working drawings coordinated with cast-in-place concrete and showing all construction, and other conditions encountered in the Work and manufacturer's approved and recommended details appropriate to construction, expansion and seismic joints as required for full reinforced Novolac epoxy resin topping corrosion protection system performance whether or not specific indication is made on the Drawings to the details of the reinforced Novolac epoxy resin topping corrosion protection system.
   3. Show interface details with other items such as thresholds, curbs, coves, equipment pads, expansion and seismic joint cover assemblies, floor hatches, ramps, steps and stair nosings.
   4. Copies of Material Safety Data Sheets (MSDS) for all products used in the Work and copies of transmittals indicating receipt of MSDS by reinforced Novolac epoxy resin topping corrosion protection systems installer.
   5. Qualifications Data: Submit qualifications data for the following:
      a. Installer.
      b. Testing laboratory.
   6. Maintenance Manual: Five copies of manufacturer's written instructions for recommended maintenance practices. Include the following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for repairs.

C. Test Reports: Submit the following:
   1. Copies of test reports from an independent testing laboratory for all physical properties of the reinforced Novolac epoxy resin topping corrosion protection system.
   2. Copies of testing agencies background and experience in performing similar tests to those specified.
   3. Final On-Site Quality Control Report: Provide ENGINEER with testing results in each area of the Work, manufacturer's recommended remedial measures, weather, humidity and dew point conditions during the time of installation and curing of the Work, and other requirements as specified for final approval.

D. Component Application and Thickness Report:

1. Copies of reports listing each component application, dry film thickness, surface temperature, component temperature, and ambient air temperature.

E. Certificates: Submit the following:
   1. Certificates stating that materials meet or exceed Specification requirements and stating that materials have been provided as specified to meet performance criteria, and installation requirements specified.
   2. Shelf life history for all products, verifying compliance with requirements specified.
   3. Evidence of acceptance of the substrate and each system component installation by the reinforced Novolac epoxy resin topping corrosion protection system manufacturer's technical representative. Include such documentation as part of the on-site quality control report submitted to ENGINEER for final approval.
   4. CONTRACTOR'S Review: Submit specified statement to ENGINEER. Show by copy of transmittal form that a copy of the statement has been transmitted to the manufacturer.
   5. Submit statement of application, as specified.

F. Warranties: Submit CONTRACTOR'S and manufacturer's written warranties.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in the reinforced Novolac epoxy resin topping corrosion protection system manufacturer's original unopened and undamaged containers, legibly labeled with information accurately representing container contents, as approved by ENGINEER.
   2. Include the following information on the label:
      a. Name of material, manufacturer and supplier.
      b. Brand name, contents, and order number.
      c. Installation, handling and protection requirements.
      d. Accurate representation of DOT classifications.
   3. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
   4. Packages showing indications of damage that may affect condition of contents are not acceptable.
   5. All DOT classified system components shall be accompanied by appropriate DOT documentation.

B. Storage of Materials:
   1. Store only approved materials on-site.
   2. Store materials in original, undamaged containers with manufacturer's labels and seals intact.
   3. Store all materials in a dry, enclosed area, off the ground and away from all possible contact with water and in a location where temperature can be constantly maintained between 50°F and 75°F and out of direct sunlight, away from open flame, sparks or other hazards in full compliance with manufacturer's recommended storage requirements.

4. Prevent damage to materials during storage primarily by minimizing the amount of time they are stored on-site before being incorporated into construction systems.
5. Do not store either white, yellow or red labeled products together.

C. Handling of Materials:
1. Do not handle, open or mix component materials, unless reinforced Novolac epoxy resin topping corrosion protection system can be properly handled as recommended by the manufacturer.
2. Do not open containers, or expose materials to detrimental conditions. Remove materials so exposed from the site.
3. Handle materials in a manner that prevents contamination and inclusion of foreign materials.
4. Do not open packages or containers until all necessary preparatory Work is complete, approved and installation will begin immediately.
5. Handle all materials in strict compliance with manufacturer's recommended safety precautions.
6. Handle volatile system components in a manner that considers their flash points.

1.5 PROJECT CONDITIONS

A. Environmental Conditions:
1. Proceed with reinforced Novolac epoxy resin topping corrosion protection system Work only when temperature and moisture conditions of substrates, air temperature, relative humidity, dewpoint and other conditions comply with the reinforced Novolac epoxy resin topping corrosion protection system manufacturer's written recommendations and when no damaging environmental conditions are forecasted for the time when the materials will be vulnerable to such environmental damage. Record all such conditions and include in final site quality control report.
2. Maintain substrate temperature before, during and after installation between 50°F and 110°F with temperature stable or falling, in accordance with reinforced Novolac epoxy resin topping corrosion protection system manufacturer's instructions.
3. Do not begin Work when relative humidity is expected to rise above 90 percent during the time of installation and catalyzation, nor, when substrate temperatures are not at least five degrees above the dewpoint temperature.
4. Do not begin reinforced Novolac epoxy resin topping corrosion protection system Work until manufacturer's recommended environmental conditions can be maintained and only when manufacturer and installer are willing to guarantee the Work as required and without additional reservations and restrictions.
5. Supplemental Heat:
a. Provide supplemental heat and protection as required to maintain reinforced Novolac epoxy resin topping corrosion protection system at minimum of 50°F during and after installation.
b. Supplemental heat and power sources, as may be required should ambient temperature fall below 50°F, are not available at the site. The provision of all supplemental heat, including fuel, equipment, operating,

monitoring and maintenance personnel, and power sources, is the responsibility of CONTRACTOR.

c. Distribute heat uniformly and provide deflection or protective screens as required to prevent concentration of heat on the reinforced Novolac epoxy resin topping corrosion protection system near heat source.

d. Source of supplemental heat shall not emit contaminants that will adversely affect the cure or performance of the reinforced Novolac epoxy resin topping corrosion protection system. Reinforced Novolac epoxy resin topping corrosion protection system so affected shall be removed and replaced with new.

B. Protection and Precautions:

1. Protect materials against damage by construction activities.
2. Protect all reinforced Novolac epoxy resin topping corrosion protection system materials and system components from all contact with non-associated construction traffic.
3. Do not install the reinforced Novolac epoxy resin topping corrosion protection system when adequate protection of the Work is not, or cannot, be made available.
4. Comply with manufacturer's written safety precautions for storage, handling, mixing and installation of each component, and with the requirements of OSHA and local governing authorities having jurisdiction at the site.
5. Environmentally isolate and enclose the Work area so that adjacent Work, and personnel adjacent to the Work area, will be unaffected by the Work of this Section.
6. Provide adequate ventilation for space and appropriate protective life support respirators for installers, during installation and curing periods, with exhaust air adequately diluted and discharged to a safe location. Avoid build-up of hazardous vapors or the creation of hazardous conditions or conditions that may retard the cure of the system.
7. Provide suitable glasses, gloves, respirators and suitable personnel protective clothing for use during installation of the reinforced Novolac epoxy resin topping corrosion protection system.
8. Provide protection of substrate surfaces, including Work protection shelters, to prevent substrate temperatures from exceeding manufacturer’s recommended installation limits.

C. Sequencing and Scheduling:

1. Proceed with the reinforced Novolac epoxy resin topping corrosion protection system only after projections and penetrations through the substrates have been installed, and when the substrate construction and framing of openings is complete.
2. Coordinate and schedule abrasive blasting, grinding and filling of substrates with underlayments, in order to bring substrates within tolerances specified.
3. Provide reinforced Novolac epoxy resin topping corrosion protection system on floor and walls of trench drains where installation of grating would cause the reinforced Novolac epoxy resin topping corrosion protection system installation difficulties, before such items have been installed. In order to advance the Work, be prepared to schedule multiple visits of the reinforced Novolac epoxy resin topping corrosion protection system installer to the site for the purpose of installing the reinforced Novolac epoxy resin topping

corrosion protection system in areas that will become inaccessible with the installation of equipment or piping, as may be required for proper sequencing of the Work.

4. Sequence the Work so that other installers do not interfere with, or need to cross, the reinforced Novolac epoxy resin topping corrosion protection system installation areas until such time as the reinforced Novolac epoxy resin topping corrosion protection system can be adequately protected from potential damage.

D. Substitutions:
   1. Do not change products, system components, colors or manufacturers after Shop Drawing and Samples approvals by ENGINEER.
   2. Clearly identify, in a manner which is highlighted to ENGINEER, all proposed substitutions, modifications, variations, unspecified features and "or equal" products. Provide complete comparative data with specified products at time of Shop Drawing submission.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Bonded Warranty: The corrosion protection system applicator shall supply a two year bond, payable to the City of Phoenix (COP), for the corrosion protection system that is approved by COP. The two year bond shall cover both the material costs and the labor costs associated with installing the approved corrosion protection system. The bond shall also be unconditional in nature covering any type of failure in the corrosion protection system and agreeing to repair or replace it at no additional cost to COP at any point during this two year period. The corrosion protection system applicator shall also supply a warranty from the corrosion protection system manufacturer addressed to the A-minus or better bonding company and COP. This warranty shall state, at a minimum, that if the corrosion protection system is applied in accordance with the manufacturer’s instructions, that the corrosion protection system will not fail for a period of two years. The definition of a corrosion protection system failure is that blistering, cracking, embrittlement, or softening of the corrosion protection system is starting to occur.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. General:
      a. Standards: Comply with applicable standards, recommendations and specified publications of ASTM, except to the extent more stringent requirements are specified or required by governing authorities having jurisdiction.

2. The completed reinforced Novolac epoxy resin topping corrosion protection system shall demonstrate the following physical properties:
   a. Coefficient of Expansion, ASTM D 696, 70 to 210 degrees F: 12 to 15 x 10-6 inches per inch per degree F.
   b. Compressive Strength, ASTM C 579: 14,000 pounds per square inch, minimum.
   c. Tensile Strength, ASTM C 307: 2,700 pounds per square inch, minimum.
   d. Abrasive Factor, CS-17 wheel, 1000 cycles, 1000-gram load, ASTM D 4060: 40 mg.
   e. Water Vapor Transmission: 0.0017 perm. in.
   f. Flame Spread, ASTM D 635: 10mm.

B. The finished reinforced Novolac epoxy resin topping corrosion protection system shall provide abrasions resistance and splash and spill protection for 72 hours at the truck unloading station, at the chemical feed facilities. The reinforced Novolac epoxy resin topping corrosion protection system will be exposed to sunlight and atmospheric conditions.
   1. 95 Percent Sulfuric Acid, at a maximum of 150°F.

2.2 MATERIALS

A. Resin: Catalyzed, Novolac epoxy: with silica fillers.

B. Concrete Surfacer: Provide a two component, epoxy-based material with inert mineral fillers recommended by the reinforced Novolac epoxy resin topping corrosion protection system manufacturer for filling concrete “bug” holes and voids in horizontal and vertical concrete surfaces, complying with the following:
   1. Adhesion to Concrete, ASTM D 4541: Cohesive failure of concrete.
   2. Compression Strength, ASTM C 579: 2000 pounds per square inch, minimum.

C. Moisture Barrier Coating: Two component water dispensed polyurethane, complying with the following:
   1. Compressive strength, ASTM C 579: 7,300 pounds per square inch, minimum.
   2. Tensile strength, ASTM D 4541: Cohesive failure of concrete.

D. Primer: Two component, 100 percent solids, moisture-tolerant, conductive, catalyzed epoxy, complying with the following:
   1. Tensile Strength, ASTM C 307: 2,000 to 2,500 pounds per square inch.
   2. Tensile Elongation, ASTM C 307: 20 to 25 percent.
   3. Adhesion to Concrete, ASTM D 4541: Cohesive failure of concrete.

E. Reinforcement: 9.8 ounce Type H glass woven roving.

F. Topcoat: Catalyzed, Novolac epoxy with silica fillers.

G. Auxiliary System Components and Accessories: Provide all auxiliary components such as accelerators, solvents, saturants, fillers, sand, smoothing liquids, hardeners, chemical-resistant sealants and cleaners as recommended by

the manufacturer for maximum chemical-resistance, maximum adhesion to substrate and full system component compatibility.

H. Sealants:
1. Exposed floor joints: Two component, 100 percent solids, polysulfide polymer based joint sealant.
2. Non-moving joints, covered with topping: 100 percent solids, pourable, two component, flexible epoxy caulk.
3. All wall joints: Two component, 100 percent solids, polysulfide polymer based joint sealant.

I. Reinforced Novolac Epoxy Resin Topping Corrosion Protection System Manufacturer:
1. The corrosion protection system specified is manufactured by Dudick, Inc. Equivalent protection systems of other manufacturers regularly producing high quality concrete corrosion protection systems and materials including providing the required material manufacturer's engineering field services may be furnished subject to review and acceptance by ENGINEER.

J. Product and Manufacturer: Provide the following:
1. PROTECTO-LINE 100XT Reinforced Novolac epoxy resin topping corrosion protection system, with Scratch-Coat 300 surfacer, Primer 67C, Shock-crete F moisture barrier coating and caulk 100XT, 139 and 149 by Dudick, Incorporated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which the reinforced Novolac epoxy resin topping corrosion protection system Work is to be performed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Concrete shall have a wood float finish. Concrete shall have cured for minimum of 28 days prior to initiation of this Work.

3.2 PREPARATION FOR CAST-IN-PLACE CONCRETE SUBSTRATES

A. Concrete shall be free of curing compounds and form release agents.

B. Test cast-in-place concrete for moisture, in compliance with ASTM D 4263, in order to determine that the maximum safe moisture-emission level, recommended by the reinforced Novolac epoxy resin topping corrosion protection system manufacturer’s written installation limitations, will not be exceeded, before installation of the reinforced Novolac epoxy resin topping corrosion protection system.

1. Perform minimum of one test for every 1000 square feet of substrate area to receive the reinforced Novolac epoxy resin topping corrosion protection system. Perform tests on areas scheduled to be coated the following day.
2. If moisture tests indicate unacceptable levels of moisture remaining in the substrate, do not install the reinforced Novolac epoxy resin topping corrosion protection system. Report existing conditions, along with manufacturer's recommendations, to ENGINEER. Allow additional time for cast-in-place concrete to dry and retest.
3. At CONTRACTOR'S option and expense, may enclose, dehumidify or provide additional heat, in order to speed the drying process. If, after remediation measures are implemented, retesting the cast-in-place concrete continues to indicate unacceptable levels of moisture, perform calcium chloride tests in accordance with ASTM F 1869. If readings are below 5 pounds per 1,000 square feet for 24 hours install the primer. If readings are between 5 and 8 pounds per 1,000 square feet for 24 hours install the moisture barrier coating, if readings are over 8 pounds per 1,000 square feet for 24 hours submit the reinforced Novolac epoxy resin topping manufacturer's recommended remedial action for ENGINEER'S approval.

C. Prepare and clean all surfaces of cast-in-place concrete to receive the reinforced Novolac epoxy resin topping corrosion protection system in compliance with ASTM D 4259 to obtain a uniform and continuous anchor profile and to provide a surface texture similar to 40 to 60-grit sandpaper with aggregate showing. Use mechanical abrading procedures and abrasive blasting procedures as specified in ASTM D 4259. Use 40 to 80-mesh abrasive and clean, dry, compressed air. Compressed air cleanliness shall be in compliance with ASTM D 4285. Pressure at blasting nozzle shall not exceed 80 psi. Do not concentrate blast on surface, but move at a fairly rapid rate to provide a surface free of laitants and contaminants. Provide post-surface preparation cleaning in accordance with ASTM D 4258 to remove loose material. Surface preparation shall open all surface air holes by removing all laitance shoulders surrounding the air holes. Vacuum all surfaces to remove all dust and sand, and wash with potable water.
   1. Provide additional surface preparation if 40 to 60-grit texture with aggregate showing is not achieved after the first mechanical preparation procedure.
   2. All surface laitance and other contaminants shall be completely removed and surface profile shall be as specified, before commencement of surfacer installation.

D. In addition to abrasive blasting, level and grind cast-in-place concrete substrates to manufacturer's recommended tolerances and to produce a smooth, uniform installation.
   1. Remove all cast-in-place concrete fins, projections and other surface irregularities that would protrude above the surfacer and finished base coat, by chipping and scarification by mechanical abrasion.

E. Adhesion Testing: Before application of the reinforced Novolac epoxy resin topping corrosion protection system, an adhesion test shall be conducted on a properly prepared concrete surface that is acceptable to the material manufacturer and ENGINEER. The test area shall be at least two square feet or larger to allow a minimum of three tests to be conducted. The test area shall be coated with the specified system and cured as recommended by the material

manufacturer. Pull-off strength adhesion tests of protection system shall be conducted by the material manufacturer in accordance with ASTM D 4541, using an Elcometer tensile adhesion tester. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed the minimum adhesion strength recommended by the material manufacturer and shall exceed the tensile strength of the concrete. If the protection system fails the adhesion test, the cause of the failure shall be determined and corrected before re-conducting the test.

F. Start of the reinforced Novolac epoxy resin topping corrosion protection system installation operations shall indicate acceptance of substrate conditions and full responsibility for the completed Work.

3.3 SYSTEMS INSTALLATION

A. The reinforced Novolac epoxy resin topping corrosion protection system shall consist of one basecoat and one finish coat. The prime coat thickness shall be at least six mils. Surfacer thickness will vary depending on concrete texture. Moisture barrier coating shall be 125 mils, minimum. The basecoat shall be 63 mils. Finish coat shall be 63 mils. The reinforced Novolac epoxy resin topping corrosion protection system shall have a total dry film thickness of at least 126 mils.

3.4 INSTALLATION ON CAST-IN-PLACE CONCRETE SUBSTRATES

A. Primer:
   1. Prime all cast-in-place concrete to receive the reinforced Novolac epoxy resin topping corrosion protection system immediately after surface preparation in order to prevent degradation of prepared surfaces.
      a. All surfaces shall be free of all laitenance and other contaminants at time of commencement of primer installation.
   2. Mix primer components as recommended by the reinforced Novolac epoxy resin topping corrosion protection system manufacturer. Add accelerator only after consultation with manufacturer’s technical representative and with the approval of ENGINEER and based on agreement as to the best approach for handling environmental conditions existing at the site during installation.
   3. Apply conductive primer using roller, prior to application of surfacer and base coat and in accordance with manufacturer's approved Shop Drawings.

B. Follow manufacturer's written instructions for mixing and catalyzing process. Install all system components within their maximum recoat times based on manufacturer’s written information, the environmental conditions existing at the site and the exposure of system components to sunlight during installation.
   1. If maximum recoat time is exceeded, sand or abrasive blast as recommended by manufacturer’s technical representative in consultation with ENGINEER, before installation of topcoat.

C. Install surfacer when primer is tacky. Trowel-apply specified surfacer and patch all cast-in-place concrete surfaces to completely fill surface air holes and

honeycombing. Level all protrusions and grind filler and surfacing compounds smooth and level with adjacent surfaces.

D. Trowel-apply specified moisture barrier coating over surfacer to form level surface.

E. Reinforced Novolac epoxy resin topping corrosion protection system shall be installed on all exposed cast-in-place concrete surfaces shown on the Drawings and specified.

F. Mix materials in the sequence required by the manufacturer.

G. After primer has dried examine surfaces for oily, amine-blush film. Remove film by washing with warm water-detergent solution.

H. Mix materials and install base coat in accordance with manufacturer's instructions.

I. Press the chopped strand fiberglass mat reinforcement into the wet base coat. Lap all glass reinforcement edges 1-inch minimum. Remove all air pockets and wrinkles. Roll glass reinforcement until it has lost its white color and turns translucent.

J. Saturate the glass reinforcement with catalyzed resin; do not puddle saturant or allow to drip.

K. Lightly broadcast clean, dry sand into the wet saturant.

L. Allow base coat to cure before proceeding. Examine base coat for amine blush and, if present, remove it by washing with a warm water detergent solution. Grind and repair sharp glass protrusions and fill voids.

M. Trowel-apply topcoat includes silica filler in quantities recommended by the reinforced Novolac epoxy resin topping corrosion protection system manufacturer. Do not power trowel concrete reinforced Novolac epoxy resin topping corrosion protection system, unless manufacturer provides written certification approved by ENGINEER that material shall experience no loss in compressive strength or tensile strength.
   1. Immediately after the trowel-applied application and before the topcoat has cured, dampen a natural bristle brush or roller with reinforced Novolac epoxy resin topping corrosion protection system manufacturer’s recommended smoothing liquid.
   2. Lightly brush or roll the wet topcoat to remove trowel marks and pinholes.

N. Repeat trowel-applied topcoat material as recommended by manufacturer for complete coverage.

O. Apply materials to tolerances specified and in the recommended quantities necessary to produce a finished system not less than specified thickness.

P. Install reinforced novolac epoxy resin topping corrosion protection system expansion and construction joints at all concrete expansion and control joints as recommended by the manufacturer.

3.5 SITE QUALITY CONTROL TESTING

A. The right is reserved by ENGINEER to invoke the following material testing procedure at any time, and any number of times, during the period of the reinforced Novolac epoxy resin topping corrosion protection system installation:
   1. Engage the service of an independent testing laboratory to sample any of the system components being used. Samples of each material delivered to the site will be taken, identified and sealed, and certified as to being the material actually applied to the surfaces in each area.
   2. A testing laboratory, selected by OWNER, as indicated in Division 1, General Requirements, will perform appropriate tests for any or all of the following characteristics:
      a. Abrasion resistance.
      b. Flexibility.
      c. Washability.
      d. Absorption.
      e. Chemical resistance.
      f. Dry opacity.
      g. Generic materials analysis including compressive strength, tensile strength and water vapor transmission.
   3. If the test results show that the material being used does not comply with the specified requirements, ENGINEER may direct CONTRACTOR to stop the installation and remove non-complying reinforced Novolac epoxy resin topping corrosion protection system; pay for testing; and prepare and repaint surfaces coated with the rejected system with material complying with the Specifications.

B. Chemical Resistant Testing: After approval of job mock-up and substrate preparations, install reinforced Novolac epoxy resin topping corrosion protection system to a minimum of eight square feet, for each chemical specified, within a chemical containment area. Installation of test area shall be supervised and approved by manufacturer’s Technical Representative as an acceptable installation. Test the reinforced Novolac epoxy resin topping corrosion protection system for a minimum of 48 hours at normal operating temperatures. Place specified chemicals at normal operating temperature to a minimum depth of 1/2-inch over the entire floor surface of the area. Maintain operating temperature of space and specified chemicals. After 48 hours remove the chemical and inspect the surfaces of the reinforced Novolac epoxy resin topping corrosion protection system. The reinforced Novolac epoxy resin topping corrosion protection system shall show no sign of delamination, cracking, crazing, color change, softening or any other physical or chemical changes whatsoever and shall be unaffected from the immersion condition. If the reinforced Novolac epoxy resin topping corrosion protection system shows deterioration, the test may be repeated at CONTRACTOR’S expense. If the reinforced Novolac epoxy resin topping corrosion protection system fails to perform according to this Section at the completion of this second test, the reinforced Novolac epoxy resin topping corrosion protection system shall be rejected by ENGINEER and an "approved equal" product shall

be submitted for approval by CONTRACTOR. Test "approved equal" product as specified herein.

C. After each component of the reinforced epoxy resin topping corrosion protection system has completely cured the material manufacturer shall record the dry film thickness and submit a report to the ENGINEER listing all components and thicknesses.

D. Notify ENGINEER after completion of installation of each component of the reinforced Novolac epoxy resin topping corrosion protection system. Mark and repair all pinholes and repair using topcoat material. After reinforced Novolac epoxy resin topping corrosion protection system is installed, the material manufacturer shall spark-test all concrete surfaces covered with reinforced Novolac epoxy resin topping corrosion protection system with a 20,000-volt AC spark tester in accordance with ASTM D 4787 and set at the recommended voltage, or as a minimum at 100 volts per mil of liner thickness. The material manufacturer shall verify the testing equipment is working properly before beginning the spark testing of the lining. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 100 percent of the reinforced Novolac epoxy resin topping corrosion protection system surface. A carbon fiber brush shall be used on the sensor electrode. Retest repair after curing.

3.6 ADJUSTMENT AND CLEANING

A. All finished reinforced Novolac epoxy resin topping corrosion protection system shall be protected from damage until Final Completion of the Work. The reinforced Novolac epoxy resin topping corrosion protection system damaged in any manner shall be repaired or replaced as required to restore specified system performance.

B. Only the original installer of the reinforced Novolac epoxy resin topping corrosion protection system shall replace deteriorated or defective Work.

C. Protection: Care shall be taken to prevent protection system materials from being dropped or spilled on adjacent surfaces, buildings, structures, or facilities. All surfaces so damaged shall be cleaned, repaired, replaced, or coated as acceptable to the ENGINEER.

+ + END OF SECTION + +

SECTION 09 96 17

EPOXY LINING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish, install and place into satisfactory service the epoxy lining system. The Work also includes:
      a. Providing openings in the epoxy lining system to accommodate the Work under this and other Section, and building into the epoxy lining system all items such as sleeves, anchor bolts, inserts and all other items to be embedded in, or inserted through, the epoxy lining system for which placement is not specifically provided under other Sections.
      b. All systems shall include scarification, acid etching and other substrate preparations, bond coats, reinforcements, underlayment fills, moisture barrier coatings, binder coats, top coats, sealants and other components and system accessories recommended by the manufacturer for cast-in-place concrete floor slabs, curbs, equipment pads, tops and sides of containment walls, trenches, steps sumps, equipment pits and similar cast-in-place concrete items, described in Part 2, below.
      c. Provide an epoxy lining corrosion protection system at the chemical storage facilities in the chemical storage areas, as shown on the Drawings.
      d. Include manufacturer's recommended details for conditions encountered in the Work and a Field Quality Control Report, including procedures, test methods, results of tests, remedial recommendations and actions.
      e. Provide complete technical services, as available from the manufacturer, and on-site technical representation by manufacturer's technical representative during the time of material delivery, storage, mock-up, substrate preparation and the advancement of installation to thirty percent of floor areas receiving concrete epoxy corrosion protection systems and during the start of field quality control testing.
   2. Extent of the epoxy lining corrosion protection system is shown on the Drawings and, in addition, includes the following:
      a. Bulk Containment Area (aluminum sulfate, ferric chloride):
         1) Floors, all equipment pads and supports, and walls up to the potential maximum liquid level.
      b. Feed Area (aluminum sulfate, copper sulfate, ferric chloride):
         1) Floors, equipment pads and supports and walls/curbing up to 8-inches.
      c. Unloading Area:
         1) Sump (aluminum sulfate, ferric chloride).

d. Bottoms and sides of all trench drains and horizontal pipe chases containing pipes transferring solutions from containment areas to point of use and all horizontal pipe chases within the containment areas.

3. Types of products required include the following:
   a. The epoxy lining corrosion protection system shall be a two component, 100 percent solids, solvent-free, epoxy resin, silica filled, high-build protective and waterproofing coating. Concrete surface primer shall be a catalyzed epoxy resin containing conductive fillers, 100 percent solids content. Sealants are two component epoxy and two component polysulfide. Moisture barrier coating shall be two component polyurethane. Finish coats shall be two component, 100 percent solids, epoxy resin.
   b. The epoxy lining corrosion protection system shall be a two component, 100 percent solids, solvent-free, fiberglass mat reinforced, flexibilized basecoat epoxy resin, silica filled, high-build protective and waterproofing coating. Concrete surface primer shall be a catalyzed epoxy resin containing fillers, 100 percent solids content. Flexible basecoat with reinforcement shall be an epoxy resin with silica fillers and chopped strand fiberglass mat. Saturant for reinforcement shall be epoxy resin. Sealants are two component epoxy and two component polysulfide. Moisture barrier coating shall be two component polyurethane. Finish coats shall be two component, 100 percent solids, epoxy resin.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the epoxy lining corrosion protection system.
   2. Coordinate and schedule preparation of substrates, before equipment and similar items are installed to avoid later difficulty, or delay, in performing the Work of this Section, and to provide substrates within tolerances and surface profile specified.
   3. Coordinate and schedule abrasive blasting of substrates to avoid later difficulty or delay in performing the Work.
   4. Coordinate the setting of drains and other items in compliance with the recommended details of the epoxy lining corrosion protection system manufacturer for complete product responsibility.
   5. Coordinate installation of reinforced epoxy resin topping corrosion protection system on existing surfaces with OWNER'S maintenance and operations staff.

C. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to, Work that is directly related to this Section.
   1. Section 03 30 00, Cast-In-Place Concrete (Large Projects).

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single installer, certified or licensed by the epoxy lining corrosion protection system manufacturer, regularly performing trowel-applied lining

installation, and with documented skill and successful experience in the installation of the types of materials required; and who agrees to employee only tradesmen who are trained, skilled and have successful experience in installing the types of materials specified.

2. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
   a. Names and telephone numbers of owners, architects or Engineer's responsible for projects.
   b. Approximate contract cost of the epoxy lining corrosion protection system.
   c. Amount of area installed.
3. Submit proof of acceptability of installer by manufacturer to ENGINEER.

B. Testing Agency Qualifications: To qualify for approval, an independent testing agency shall demonstrate to ENGINEER'S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E 329 and as documented according to ASTM E 548, without delaying the Work.

C. Source Quality Control:
1. Engage a single manufacturer who shall furnish the services of a technical representative to assist CONTRACTOR, ENGINEER and OWNER by providing technical opinions on the adequacy of materials and methods of installation and site quality control testing. The epoxy lining corrosion protection system material manufacturer shall provide engineering field services to review the project and the material application prior to surface preparation: to approve the applicator, the materials used, and the procedure to be used; to provide the minimum pull-off adhesion strength, when testing for adhesion; to observe and approve surface preparation; and to observe application. The field representative of the epoxy lining corrosion protection system material manufacturer shall submit, through CONTRACTOR, written approvals of the proposed protection system materials, application procedures, applicator, and surface preparation. The engineering field representative shall be an employee of the material manufacturer.
2. Furnish such services during the time of delivery, storage, mock-up installation, installation and on-site quality control testing of all epoxy lining corrosion protection system components.
3. Engage a manufacturer who will provide complete technical services including preparation and review of Shop Drawings, installation methods and proposed detailing.
4. Provide all components of the epoxy lining corrosion protection system produced by a single manufacturer, including recommended primers, base coat, chopped strand fiberglass mat, sealants and topcoat materials.
5. Certify product shelf life history for each system component. Do not use resins and catalysts manufactured more than six months prior to the time they will be incorporated into the Work.
6. Certify that all epoxy lining corrosion protection system materials have been stored in full compliance with all storage recommendations of the epoxy lining corrosion protection system manufacturer and that resins, catalysts and other sensitive auxiliary system components have been constantly

stored between 50°F and 75°F, and have not, nor will be, subjected to freezing temperatures.

D. Performance Criteria:
   1. Manufacturers of "or equal" products shall provide direct property comparison with the materials specified in addition to complying with all other requirements of the Specifications. "Or equal" products shall employ the same generic materials and system components as the epoxy lining corrosion protection system specified.
   2. CONTRACTOR'S Review: Submit to ENGINEER a written statement signed by CONTRACTOR, stating that the Contract Documents have been reviewed with the epoxy lining corrosion protection system material manufacturer who confirms that, if properly installed, the specified system is capable of providing performance criteria specified, is appropriate for installation shown on the Drawings and that the details proposed for use in the Work are not in conflict with the manufacturer's details.
   3. Statement of Application: Upon completion of the epoxy lining corrosion protection system Work, certify to ENGINEER and OWNER that the Work complies with the requirements of this Section, was installed in compliance with manufacturer's written recommendations, and that the installation methods were proper and adequate for the conditions of installation and use.

E. Referenced Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ASTM C 307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts and Monolithic Surfacings.
   2. ASTM C 579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
   3. ASTM D 635, Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   4. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion.
   5. ASTM D 2200, Pictorial Surface Preparation Standards for Painting Steel Surfaces.
   6. ASTM D 4060, Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   7. ASTM D 4259, Practice for Abrading Concrete.
   8. ASTM D 4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   9. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed Air.
   10. ASTM D 4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
   11. ASTM D 4541, Test Method for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
   12. ASTM D 7234, – Standard Test Method for Pull-off Adhesion Strength of Coatings on Concrete Using Portable Pull-off Adhesion Testers.
   13. ASTM D 4787, Practice for Continuity Verification of Liquid or Sheet Linings Applied To Concrete Substrates.
   14. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
   15. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

16. ASTM F 1869, Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
17. National Association of Corrosion Engineers (NACE), Essentials of Surface Preparation.
18. Steel Structures Painting Council, SSPC - Volume 2, Systems and Specifications.
19. Steel Structures Painting Council, SSPC - PA2, Measurement of Dry Coating Thickness with Magnetic Gages.
20. Steel Structures Painting Council, SSPC - VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.

F. Allowable Installation Tolerances:
   1. Do not install Work until substrate preparation and tolerances have been approved by ENGINEER, the epoxy lining corrosion protection system manufacturer's technical representative and the epoxy lining corrosion protection system installer, and CONTRACTOR has verified to ENGINEER, in writing, that substrates are within tolerances and profiles specified and acceptable to produce approved Work. Work advanced, for any reason, without such verification shall be stopped, and the epoxy lining corrosion protection system removed and replaced with new material if substrates are determined to be unacceptable for approved Work.
   2. Substrate Tolerances:
      a. Out-of-Plane: 1/8-inch maximum in ten feet and 1/16-inch maximum in any 12-inches measured along the plane.
      b. Maximum Offset in Plane Alignment: 1/16-inch.
      c. Variation From Slope: 1/8-inch maximum in ten feet.
   3. Epoxy Lining Corrosion Protection System Tolerances:
      a. Finish epoxy lining corrosion protection systems level to 1/8-inch in ten feet with smooth continuous uniformly sloped-to-drain planes.
      b. Provide smooth continuous color with no color streaks or inconsistencies with smoothly textured non-slip finish.

G. Pre-Installation Meeting:
   1. Before erecting mock-ups, CONTRACTOR, installer, and technical representative of the epoxy lining corrosion protection system manufacturer shall meet on-site with ENGINEER to discuss approved products and workmanship to ensure proper application of the epoxy corrosion protection system components and substrate preparation requirements.
   2. Review foreseeable methods and procedures related to the epoxy lining corrosion protection system Work, including, but not necessarily limited to, the following:
      a. Review Project requirements and the Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review status of substrate Work, including approval of surface preparations and similar considerations.
      d. Review requirements of on-site quality control testing and requirements for preparing quality control report as specified herein.
      e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
      f. Review required inspection, testing and certifying.

g. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
h. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
i. Review procedures required for the protection of the epoxy lining corrosion protection system during the remainder of the construction period.

3. Record the discussions of the Pre-Installation Meeting and the decisions and agreements or disagreements reached, and furnish a copy for the record to each party attending. Record any revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.
4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

H. Mock-Ups:
1. Prior to the installation of the epoxy lining corrosion protection system and auxiliary system components, but after ENGINEER'S approval of samples and Shop Drawings, install eight-foot square stepped-back mock-ups of the systems showing each system component, in areas selected by ENGINEER, to show representative installation of the Work. Include methods of installation typical to the Work, including penetrations and cove details, using all system components required for the Work.
2. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of an epoxy lining corrosion protection system Work. Retain and protect mock-ups during construction as one standard for judging completed an epoxy lining corrosion protection system Work. Do not alter mock-ups after approval by ENGINEER.
a. Finished Work, in compliance with visual qualities of mock-ups, that fails other on-site quality control testing procedures shall be replaced by CONTRACTOR with new materials.
3. Epoxy lining corrosion protection system Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material.
4. Build as many mock-ups as required to achieve ENGINEER'S acceptance of the epoxy lining corrosion protection system.
5. Epoxy lining corrosion protection system Work that proceeds without approved mock-ups shall be stopped, and mock-ups prepared for approval.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Stepped-back epoxy lining corrosion protection system applied to a 12-inch by 12-inch by 2-inch concrete sample panel showing specified surface preparation of concrete, each showing original unprepared surface in addition to each component of the epoxy lining corrosion protection system. Prepare sample panels such that all system components are adequately exposed to view. Apply epoxy lining corrosion protection system to only one-half of the sample board, leaving the other half visible and with required substrate preparation.
2. Full selection of manufacturer's standard and custom colors for selection by ENGINEER. ENGINEER will preliminarily select a maximum of four colors

for consideration for use in the Work. Prepare 12-inch by 12-inch samples of each color. From these the ENGINEER will select a maximum of four colors to be used in the Work. ENGINEER will provide CONTRACTOR with locations of each color after this final selection. In addition to color, provide range of textures from smooth to heavily non-slip for selection for use on job mock-up panel.

3. Sample submittals will be reviewed for number of system components only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of specifications, technical information, installation instructions and general recommendations from the epoxy lining corrosion protection system manufacturer for lining required. Include requirements for environmental conditions and other conditions required for an acceptable installation, providing features and performance as stated in manufacturer's literature.
   2. Drawings showing extent of each component of each system used in the Work including all items receiving epoxy lining corrosion protection system such as equipment pads, curbs, sumps, pipe trenches and similar items and surfaces and all details required for the Work referencing required system components provided as samples to ENGINEER. Provide working drawings coordinated with cast-in-place concrete and showing all construction, and other conditions encountered in the Work and manufacturer's approved and recommended details appropriate to construction, expansion and seismic joints as required for full epoxy lining corrosion protection system performance whether or not specific indication is made on the Drawings to the details of the epoxy lining corrosion protection system.
   3. Show interface details with other items such as thresholds, curbs, coves, equipment pads, expansion and seismic joint cover assemblies, floor hatches, ramps, steps and stair nosings.
   4. Copies of Material Safety Data Sheets (MSDS) for all products used in the Work and copies of transmittals indicating receipt of MSDS by epoxy lining corrosion protection systems installer.
   5. Qualifications Data: Submit qualifications data for the following:
      a. Installer.
      b. Testing laboratory.
   6. Maintenance Manual: Five copies of manufacturer's written instructions for recommended maintenance practices. Include the following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for repairs.

C. Test Reports: Submit the following:
   1. Copies of test reports from an independent testing laboratory for all physical properties of the epoxy lining corrosion protection system.
   2. Copies of testing agencies background and experience in performing similar tests to those specified.
   3. Final On-Site Quality Control Report: Provide ENGINEER with testing results in each area of the Work, manufacturer's recommended remedial

measures, weather, humidity and dew point conditions during the time of installation and curing of the Work, and other requirements as specified for final approval.

D. Component Application and Thickness Report:
   1. Copies of reports listing each component application, dry film thickness, surface temperature, component temperature, and ambient air temperature.

E. Certificates: Submit the following:
   1. Certificates stating that materials meet or exceed Specification requirements and stating that materials have been provided as specified to meet performance criteria, and installation requirements specified.
   2. Shelf life history for all products, verifying compliance with requirements specified.
   3. Evidence of acceptance of the substrate and each system component installation by the epoxy lining corrosion protection system materials manufacturer's technical representative. Include such documentation as part of the on-site quality control report submitted to ENGINEER for final approval.
   4. CONTRACTOR'S Review: Submit specified statement to ENGINEER. Show by copy of transmittal form that a copy of the statement has been transmitted to the manufacturer.
   5. Submit statement of application, as specified.

F. Warranties: Submit CONTRACTOR'S and manufacturer's written warranties.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in the epoxy lining corrosion protection system manufacturer's original unopened and undamaged containers, legibly labeled with information accurately representing container contents, as approved by ENGINEER.
   2. Include the following information on the label:
      a. Name of material, manufacturer and supplier.
      b. Brand name, contents, and order number.
      c. Installation, handling and protection requirements.
      d. Accurate representation of DOT classifications.
   3. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
   4. Packages showing indications of damage that may affect condition of contents are not acceptable.
   5. All DOT classified system components shall be accompanied by appropriate DOT documentation.

B. Storage of Materials:
   1. Store only approved materials on-site.
   2. Store materials in original, undamaged containers with manufacture's labels and seals intact.
   3. Store all materials in a dry, enclosed area, off the ground and away from all possible contact with water and in a location where temperature can be

constantly maintained between 50°F and 75°F and out of direct sunlight, away from open flame, sparks or other hazards in full compliance with manufacturer's recommended storage requirements.

4. Prevent damage to materials during storage primarily by minimizing the amount of time they are stored on-site before being incorporated into construction systems.
5. Do not store white, yellow or red labeled products together.

C. Handling of Materials:
   1. Do not handle, open or mix component materials, unless epoxy lining corrosion protection system can be properly handled as recommended by the manufacturer.
   2. Do not open containers, or expose materials to detrimental conditions. Remove materials so exposed from the site.
   3. Handle materials in a manner that prevents contamination and inclusion of foreign materials.
   4. Do not open packages or containers until all necessary preparatory Work is complete, approved and installation will begin immediately.
   5. Handle all materials in strict compliance with manufacturer's recommended safety precautions.
   6. Handle volatile system components in a manner that considers their flash points.

1.5 PROJECT CONDITIONS

A. Environmental Conditions:
   1. Proceed with epoxy lining corrosion protection system Work only when temperature and moisture conditions of substrates, air temperature, relative humidity, dewpoint and other conditions comply with the epoxy lining corrosion protection system manufacturer's written recommendations and when no damaging environmental conditions are forecasted for the time when the materials will be vulnerable to such environmental damage. Record all such conditions and include in final site quality control report.
   2. Maintain substrate temperature before, during and after installation between 50°F and 110°F with temperature stable or falling, in accordance with epoxy lining corrosion protection system manufacturer's instructions.
   3. Do not begin Work when relative humidity is expected to rise above 90 percent during the time of installation and catalyzation, nor, when substrate temperatures are not at least five degrees above the dewpoint temperature.
   4. Do not begin epoxy lining corrosion protection system Work until manufacturer's recommended environmental conditions can be maintained and only when manufacturer and installer are willing to guarantee the Work as required and without additional reservations and restrictions.
   5. Supplemental Heat:
      a. Provide supplemental heat and protection as required to maintain epoxy lining corrosion protection system at minimum of 50°F during and after installation.
      b. Supplemental heat and power sources, as may be required should ambient temperature fall below 50°F, are not available at the site. The provision of all supplemental heat, including fuel, equipment, operating,

monitoring and maintenance personnel, and power sources, is the responsibility of CONTRACTOR.

c. Distribute heat uniformly and provide deflection or protective screens as required to prevent concentration of heat on the epoxy lining corrosion protection system near heat source.

d. Source of supplemental heat shall not emit contaminants that will adversely affect the cure or performance of the epoxy lining corrosion protection system. Epoxy lining corrosion protection systems so affected shall be removed and replaced with new.

B. Protection and Precautions:

1. Protect materials against damage by construction activities.
2. Protect all epoxy lining corrosion protection system materials and system components from all contact with non-associated construction traffic.
3. Do not install the epoxy lining corrosion protection system when adequate protection of the Work is not, or cannot, be made available.
4. Comply with manufacturers' written safety precautions for storage, handling, mixing and installation of each component, and with the requirements of OSHA and local governing authorities having jurisdiction at the site.
5. Environmentally isolate and enclose the Work area so that adjacent Work, and personnel adjacent to the Work area, will be unaffected by the Work of this Section.
6. Provide adequate ventilation for space and appropriate protective life support respirators for installers, during installation and curing periods, with exhaust air adequately diluted and discharged to a safe location. Avoid build-up of hazardous vapors or the creation of hazardous conditions or conditions that may retard the cure of the system.
7. Provide suitable glasses, gloves, respirators and suitable personnel protective clothing for use during installation of the epoxy lining corrosion protection system.
8. Provide protection of substrate surfaces, including Work protection shelters, to prevent substrate temperatures from exceeding manufacturer's recommended installation limits.

C. Sequencing and Scheduling:

1. Proceed with the epoxy lining corrosion protection system only after projections and penetrations through the substrates have been installed, and when the substrate construction and framing of openings is complete.
2. Coordinate and schedule abrasive blasting, grinding and filling of substrates with underlayments, in order to bring substrates within tolerances specified.
3. Provide epoxy lining corrosion protection system on top of equipment pads, within horizontal pipe chases and similar locations where installation of equipment, piping and similar items would cause the epoxy lining corrosion protection system installation difficulties, before such equipment, piping and similar items have been installed. In order to advance the Work, be prepared to schedule multiple visits of a epoxy lining corrosion protection system installer to the site for the purpose of installing the epoxy lining corrosion protection system in areas that will become inaccessible with the installation of equipment or piping, as may be required for proper sequencing of the Work.

4. Sequence the Work so that other installers do not interfere with, or need to cross, the epoxy lining corrosion protection system installation areas until such time as the epoxy lining corrosion protection system can be adequately protected from potential damage.

D. Substitutions:
   1. Do not change products, system components, colors or manufacturers after Shop Drawing and Samples approvals by ENGINEER.
   2. Clearly identify, in a manner which is highlighted to ENGINEER, all proposed substitutions, modifications, variations, unspecified features and “or equal” products. Provide complete comparative data with specified products at time of Shop Drawing submission.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Bonded Warranty: The corrosion protection system applicator shall supply a two year bond, payable to the City of Phoenix (COP), for the corrosion protection system that is approved by COP. The two year bond shall cover both the material costs and the labor costs associated with installing the approved corrosion protection system. The bond shall also be unconditional in nature covering any type of failure in the corrosion protection system and agreeing to repair or replace it at no additional cost to COP at any point during this two year period. The corrosion protection system applicator shall also supply a warranty from the corrosion protection system manufacturer addressed to the A-minus or better bonding company and COP. This warranty shall state, at a minimum, that if the corrosion protection system is applied in accordance with the manufacturer’s instructions, that the corrosion protection system will not fail for a period of two years. The definition of a corrosion protection system failure is that blistering, cracking, embrittlement, or softening of the corrosion protection system is starting to occur.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. General:
      a. Standards: Comply with applicable standards, recommendations and specified publications of ASTM, except to the extent more stringent requirements are specified or required by governing authorities having jurisdiction.
   2. The completed epoxy lining corrosion protection system shall demonstrate the following physical properties:
      a. Tensile Strength, ASTM C 307: 2,870 pounds per square inch, minimum.
      b. Abrasive Factor, CS-17 wheel, 1000 cycles, 1000-gram load, ASTM D 4060: 92 mg.

c. Water Vapor Transmission: 0.0018 perm. in.
d. Flame Spread, ASTM D 635: 5mm.

3. The completed epoxy lining corrosion protection system shall demonstrate the following physical properties:
   a. Compressive strength, ASTM C 579; 6,000 pounds per square, inch minimum.
   b. Tensile strength, ASTM C 307; 4,500 to 5,000 pounds per square inch, minimum.
   c. Shored hardness, ASTM D 2240: 70 to 75.

B. The finished epoxy lining corrosion protection system shall be capable of providing splash and spill protection for 72 hours, at temperatures from 50° to 120°F, from the chemical exposures listed below, with no adverse effects. Products capable of only intermittent spill exposure resistance are not acceptable. The epoxy lining corrosion protection system will be exposed to sunlight and atmospheric conditions.
   1. 40 Percent Aluminum Sulfate, 120°F.
   2. Copper Sulfate, 120°F.
   3. 45 percent ferric chloride, 120°F.

2.2 MATERIALS

A. Resin: Catalyzed, epoxy: With silica fillers.

B. Concrete Surfacer: Provide a two-component, epoxy-based material with inert mineral fillers recommended by the epoxy lining corrosion protection system manufacturer for filling concrete "bug" holes and voids in horizontal and vertical concrete surfaces, complying with the following:
   1. Adhesion to Concrete, ASTM D 4541: Cohesive failure of concrete.
   2. Compression Strength, ASTM C 579: 2000 pounds per square inch, minimum.

C. Moisture Barrier Coating: Two component water dispensed polyurethane, complying with the following:
   1. Compressive strength, ASTM C 579: 7,300 pounds per square inch, minimum.
   2. Tensile strength, ASTM D 4541: Cohesive failure of concrete.

D. Primer: Two-component, 100 percent solids, moisture-tolerant, conductive, catalyzed epoxy, complying with the following:
   1. Tensile Strength, ASTM C 307: 2,000 to 2,500 pounds per square inch.
   2. Tensile Elongation, ASTM C 307: 20 to 25 percent.
   3. Adhesion to Concrete, ASTM D 4541: Cohesive failure of concrete.

E. Reinforcement: One ounce chopped strand fiberglass mat.

F. Topcoat: Catalyzed, epoxy with silica fillers.

G. Auxiliary System Components and Accessories: CONTRACTOR shall provide all auxiliary components such as accelerators, solvents, saturants, fillers, sand, smoothing liquids, hardeners, and cleaners as recommended by the

manufacturer for maximum chemical-resistance, maximum adhesion to substrate and full system component compatibility.

H. Sealants:
1. Exposed floor joints: Two component, 100 percent solids, polysulfide polymer based joint sealant.
2. Non-moving joints, covered with topping: 100 percent solids, pourable, two component, flexible epoxy caulk.
3. All wall joints: Two component, 100 percent solids, polysulfide polymer based joint sealant.

I. Epoxy Lining Corrosion Protection System Manufacturer:
1. The corrosion protection system specified is manufactured by Dudick, Inc. Equivalent protection systems of other manufacturers regularly producing high quality concrete corrosion protection systems and materials including providing the required material manufacturer's engineering field services may be furnished subject to review and acceptance by ENGINEER.

J. Product and Manufacturer: Provide one of the following:
1. PROTECTO-COAT 300 Improved Coating System, with Scratch-Coat 300 Surfacer, Primer 67C, Shock-Crete F moisture barrier coating and caulk 139 and 149, by Dudick, Incorporated.
2. PROTECTO-FLEX 310 Lining System, with Scratch-Coat 300 Surfacer, Primer 67C, Shock-Crete F moisture barrier coating and caulk 139 and 149, by Dudick, Incorporated.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the areas and conditions under which the epoxy lining corrosion protection system Work is to be performed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Concrete shall have a wood float finish. Concrete shall have cured for minimum of 28 days prior to initiation of this Work.

3.2 PREPARATION FOR CAST-IN-PLACE CONCRETE SUBSTRATES

A. Concrete shall be free of curing compounds and form release agents.

B. Test cast-in-place concrete for moisture, in compliance with ASTM D 4263, in order to determine that the maximum safe moisture-emission level, recommended by the epoxy lining corrosion protection system manufacturer’s written installation limitations, will not be exceeded, before installation of the epoxy lining corrosion protection system.

1. Perform minimum of one test for every 1000 square feet of substrate area to receive the epoxy lining corrosion protection system. Perform tests on areas scheduled to be coated the following day.
2. If moisture tests indicate unacceptable levels of moisture remaining in the substrate, do not install the epoxy lining corrosion protection system. Report existing conditions, along with manufacturer's recommendations, to ENGINEER. Allow additional time for cast-in-place concrete to dry and retest.
3. CONTRACTOR may, at its option and expense, enclose, dehumidify or provide additional heat, in order to speed the drying process. If, after remediation measures are implemented, retesting the cast-in-place concrete continues to indicate unacceptable levels of moisture, perform calcium chloride tests in accordance with ASTM F 1869. If readings are below 5 pounds per 1,000 square feet for 24 hours install the primer. If readings are between 5 and 8 pounds per 1,000 square feet for 24 hours install the moisture barrier coating, if readings are over 8 pounds per 1,000 square feet for 24 hours submit the epoxy lining manufacturer's recommended remedial action for ENGINEER'S approval.

C. Prepare and clean all surfaces of cast-in-place concrete to receive the epoxy lining corrosion protection system in compliance with ASTM D 4259 to obtain a uniform and continuous anchor profile and to provide a surface texture similar to 40 to 60-grit sandpaper with aggregate showing. Use mechanical abrading procedures and abrasive blasting procedures as specified in ASTM D 4259. Use 40 to 80-mesh abrasive and clean, dry, compressed air. Compressed air cleanliness shall be in compliance with ASTM D 4285. Pressure at blasting nozzle shall not exceed 80 psi. Do not concentrate blast on surface, but move at a fairly rapid rate to provide a surface free of laitants and contaminants. Provide post-surface preparation cleaning in accordance with ASTM D 4258 to remove loose material. Surface preparation shall open all surface air holes by removing all laitance shoulders surrounding the air holes. Vacuum all surfaces to remove all dust and sand, and wash with potable water.
   1. Provide additional surface preparation if 40 to 60-grit texture with aggregate showing is not achieved after the first mechanical preparation procedure.
   2. All surface laitance and other contaminants shall be completely removed and surface profile shall be as specified, before commencement of surfacer installation.

D. In addition to abrasive blasting, level and grind cast-in-place concrete substrates to manufacturer's recommended tolerances and to produce a smooth, uniform installation.
   1. Remove all cast-in-place concrete fins, projections and other surface irregularities that would protrude above the surfacer and finished base coat, by chipping and scarification by mechanical abrasion.

E. Adhesion Testing: Before application of the epoxy lining corrosion protection system, an adhesion test shall be conducted on a properly prepared concrete surface that is acceptable to the material manufacturer and ENGINEER. The test area shall be at least two square feet or larger to allow a minimum of three tests to be conducted. The test area shall be coated with the specified system and cured as recommended by the material manufacturer. Pull-off strength

adhesion tests of protection system shall be conducted by the material manufacturer in accordance with ASTM D 4541, using an Elcometer tensile adhesion tester. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed the minimum adhesion strength recommended by the material manufacturer and shall exceed the tensile strength of the concrete. If the protection system fails the adhesion test, the cause of the failure shall be determined and corrected before re-conducting the test.

F. Start of the epoxy lining corrosion protection system installation operations shall indicate acceptance of substrate conditions and full responsibility for the completed Work.

3.3 SYSTEMS INSTALLATION

A. The epoxy lining corrosion protection system shall be applied in three or more coats. The epoxy lining corrosion protection system shall consist of one prime coat and two or more finish coats. Surfacer thickness will vary depending on concrete texture. Moisture barrier coating shall be 125 mils, minimum. The prime coat wet film thickness shall be at least six mils. Each finish coat shall be six to eight mils dry film thickness. The epoxy lining coating corrosion protection system shall have a total dry film thickness of at least 20 mils.

B. The epoxy lining corrosion protection system shall be applied in four or more coats. The epoxy lining corrosion protection system shall consist of a prime coat, a flexible reinforced basecoat, reinforcement and saturant, and two or more finish coats. The prime coat shall be at least six mils wet film thickness. Surfacer thickness will vary depending on concrete texture. Moisture barrier coating shall be 125 mils, minimum. The basecoat shall be trowel applied, to a thickness of 63 mils (1/16-inch). The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be eight mils dry film thickness. The epoxy lining corrosion protection system shall have a total dry film thickness of at least 90 mils.

3.4 INSTALLATION ON CAST-IN-PLACE CONCRETE SUBSTRATES

A. Primer:
   1. Prime all cast-in-place concrete to receive the epoxy lining corrosion protection system immediately after surface preparation in order to prevent degradation of prepared surfaces.
      a. All surfaces shall be free of all laitenance and other contaminants at time of commencement of primer installation.
   2. Mix primer components as recommended by the epoxy lining corrosion protection system manufacturer. Add accelerator only after consultation with manufacturer's technical representative and with the approval of ENGINEER and based on agreement as to the best approach for handling environmental conditions existing at the site during installation.
   3. Apply conductive primer using roller, prior to application of surfacer and base coat and in accordance with manufacturer's approved Shop Drawings.

B. Follow manufacturer's written instructions for mixing and catalyzing process. Install all system components within their maximum recoat times based on

manufacturer's written information, the environmental conditions existing at the site and the exposure of system components to sunlight during installation.

1. If maximum recoat time is exceeded, sand or abrasive blast as recommended by manufacturer's technical representative in consultation with ENGINEER, before installation of topcoat.

C. Install surfacer when primer is tacky. Trowel-apply specified surfacer and patch all cast-in-place concrete surfaces to completely fill surface air holes and honeycombing. Level all protrusions and grind filler and surfacing compounds smooth and level with adjacent surfaces.

D. Trowel-apply specified moisture barrier coating over surfacer to form level surface.

E. An epoxy lining corrosion protection system lining shall be installed on all exposed cast-in-place concrete surfaces shown on the Drawings and specified.

F. Mix materials in the sequence required by the manufacturer.

G. After primer has dried examine surfaces for oily, amine-blush film. Remove film by washing with warm water-detergent solution.

H. Mix materials and install base coat in accordance with manufacturer's instructions.

I. Press the chopped strand fiberglass mat reinforcement into the wet base coat. Lap all glass reinforcement edges 1-inch minimum. Remove all air pockets and wrinkles. Roll glass reinforcement until it has lost its white color and turns translucent.

J. Saturate the glass reinforcement with catalyzed resin; do not puddle saturant or allow to drip.

K. Lightly broadcast clean, dry sand into the wet saturant.

L. Allow base coat to cure before proceeding. Examine base coat for amine blush and, if present, remove it by washing with a warm water detergent solution. Grind and repair sharp glass protrusions and fill voids.

M. Brush, roll or spray apply topcoat as recommended by the epoxy lining corrosion protection system manufacturer.

N. Repeat trowel-applied topcoat material as recommended by manufacturer for complete coverage.

O. Apply materials to tolerances specified and in the recommended quantities necessary to produce a finished system not less than thickness specified.

P. Install epoxy lining corrosion protection system expansion and construction joints at all concrete expansion and control joints as recommended by the manufacturer.

3.5 SITE QUALITY CONTROL TESTING

A. The right is reserved by ENGINEER to invoke the following material testing procedure at any time, and any number of times, during the period of the epoxy lining corrosion protection system installation:
   1. Engage the service of an independent testing laboratory to sample any of the system components being used. Samples of each material delivered to the site will be taken, identified and sealed, and certified as to being the material actually applied to the surfaces in each area.
   2. A testing laboratory, selected by OWNER, as indicated in Division 1, General Requirements, will perform appropriate tests for any or all of the following characteristics:
      a. Abrasion resistance.
      b. Flexibility.
      c. Washability.
      d. Absorption.
      e. Chemical resistance.
      f. Dry opacity.
      g. Generic materials analysis including compressive strength, tensile strength and water vapor transmission.
   3. If the test results show that the material being used does not comply with the specified requirements, CONTRACTOR may be directed to stop the installation and remove non-complying epoxy lining corrosion protection system; pay for testing; and prepare and repaint surfaces coated with the rejected system with material complying with the Specifications.

B. CONTRACTOR will notify ENGINEER after completion of installation of each component of the epoxy lining corrosion protection system. After inspection and checking of film thickness, and for other imperfections, and after approval by ENGINEER, proceed with the succeeding coat. Provide dry-film thickness gages for checking the film thickness and visual standards to check surface preparation. Calibrate dry film thickness gage at the site using Bureau of Standards standard shim blocks. Provide holiday detector for holiday testing. The holiday detector will remain the property of CONTRACTOR.
   1. Product and Manufacturer: Provide the following:
      a. Film Thickness Tester: Model FM-III as manufactured by Mikrotest, (Furnish Two).
      b. Holiday Detector: Model M-1 as manufactured by Tinker & Rasor.
      c. Visual Standards - ASTM D 2200 and SSPC (VIS 1).
   2. ENGINEER shall witness all holiday testing and shall be notified of all scheduled testing 24 hours in advance.
   3. Additional coats shall be applied, if required, to produce the specified film thickness and to correct holidays and to completely fill all surface air holes.

C. Measure thickness of dry film nonmagnetic coatings following recommendations of SSPC-PA 2. These procedures are intended to supplement manufacturers' approved instructions for the manual operation of measurement gages and are not intended to replace them.

D. Chemical Resistant Testing: After approval of job mock-up and substrate preparations, install epoxy lining corrosion protection system to a minimum of

eight square feet, for each system specified, within a chemical containment area. Installation of test area shall be supervised and approved by manufacturer's Technical Representative as an acceptable installation. Test the epoxy lining protection system for a minimum of 48 hours at normal operating temperatures. Place specified chemicals at normal operating temperature to a minimum depth of 1/2-inch over the entire floor surface of the area. Maintain operating temperature of space and specified chemicals. After 48 hours remove the chemical and inspect the surfaces of the epoxy lining corrosion protection system. The epoxy lining corrosion protection systems shall show no sign of delamination, cracking, crazing, color change, softening or any other physical or chemical changes whatsoever and shall be unaffected from the immersion condition. If the epoxy lining corrosion protection systems show deterioration, the test may be repeated at CONTRACTOR'S expense. If the epoxy lining corrosion protection systems fail to perform according to this Section at the completion of this second test, the epoxy lining corrosion protection systems shall be rejected by ENGINEER and an "approved equal" product shall be submitted for approval by CONTRACTOR. Test "approved equal" product as specified herein.

E. Mark and repair all pinholes and repair using topcoat material. After the epoxy lining corrosion protection system is installed, the material manufacturer shall spark-test all concrete surfaces covered with the epoxy lining corrosion protection system with a 20,000-volt AC spark tester in accordance with ASTM D 4787 and set at the recommended voltage, or as a minimum at 100 volts per mil of liner thickness. The material manufacturer shall verify the testing equipment is working properly before beginning the spark testing of the lining. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 100 percent of the lining surface. A carbon fiber brush shall be used on the sensor electrode. Retest repair after curing.

3.6 ADJUSTMENT AND CLEANING

A. All finished epoxy lining corrosion protection systems shall be protected from damage until Final Completion of the Work. The epoxy lining corrosion protection system damaged in any manner shall be repaired or replaced as required to restore specified system performance.

B. Only the original installer of the epoxy lining corrosion protection system shall replace deteriorated or defective Work.

C. Protection: Care shall be taken to prevent protection system materials from being dropped or spilled on adjacent surfaces, buildings, structures, or facilities. All surfaces so damaged shall be cleaned, repaired, replaced, or coated as acceptable to the ENGINEER.

+ + END OF SECTION + +

SECTION 09 96 22

LINING OF SANITARY SEWER MANHOLES WITH ULTRA-HIGH BUILD STRUCTURAL EPOXY

PART 1 - GENERAL

1.1 SCOPE

A. A manufacturer certified Applicator shall provide all labor, materials, equipment, incidentals, and quality requirements for concrete for surface preparation, repair or resurfacing, and ultra-high build, Structural Epoxy lining work to the entire interior surfaces of the structures as shown on drawings and specified herein.

B. This Section's intent is to provide minimum requirements of an installation of an ultra-high build, high strength, structural epoxy system; and the lining of newly installed specified concrete/masonry structures and surfaces exposed to municipal sanitary sewage by an applied and bonded application of high performance, 100% solids, ultra-high build, structural grade, applied fiber-reinforced-polymer (FRP) epoxy coating/lining system (Structural Epoxy).

C. This Section's intent is for concrete and/or other masonry structures which are exposed to or in contact with municipal sanitary sewage; constituting municipal sanitary sewage from collection systems (sanitary sewer and/or stormwater), where sewage contact and exposure to hydrogen sulfide are present. Not intended for non-sewage applications or industrial waste.

D. Structural Epoxy minimum film thickness specified herein is designed and intended for applied and bonded coating/lining, delivering barrier protection with high mechanical strength with a reinforced film to bridge and seal against low pressure forces of effective lateral earth pressure, moisture vapor transmission (MVT), hydrostatic head pressure, and inflow and infiltration (I&I) once cured; while protecting from effluent and H2S. Design thickness herein also accounts for long term performance; as unintentionally there may be circumstances that may prevent bonding in certain areas that an engineered Structural Epoxy is designed to bridge (with limitations), whereas non-structural coatings may not. Not intended: excessive or high-pressure forces and loading, or other force considerations for full structural reinstatement without a qualified assessment with calculated, verified and adjusted structural thickness calculations performed and certified by a registered Professional Engineer (film or system thicknesses may change depending on types of forces, force values and other variables, engineering assessments and calculations).

E. Types of Structural Epoxy lining for concrete Work required can include but are not necessarily limited to the following:

1. Chemical grout
2. Cementitious repair mortar

3. Epoxy cementitious resurfacer
4. Structural epoxy lining
5. Manhole chimney joint sealant
6. Miscellaneous materials

1.2 COORDINATION

A. Coordinate surface preparation of substrates to avoid later difficulty or delay in performing the Work of this Section.

B. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to application of the Structural Epoxy lining.

C. The Contractor shall coordinate with Engineer regarding the availability of work areas, completion times, safety, access, and other factors which can impact plant operations.

1.3 RELATED SECTIONS

A. Section 01 33 00, Submittal Procedures

B. Section 03 30 00, Cast-in-Place Concrete

C. Section 03 60 00, Grouting.

1.4 REFERENCES

A. This Section contains references to the governing standards and documents listed below. They are a part of this Section as specified and modified; the current version shall apply unless otherwise noted. In case of conflict between the requirements of this section and those of the listed documents, the more stringent of the requirements shall prevail.

1. American Concrete Institute, (ACI)
    a. ACI 301 – Specifications for Structural Concrete
2. ASTM International, (ASTM)
    a. ASTM C 868 – Standard Test Method for Chemical Resistance of Protective Linings
    b. ASTM C 1583/1583M – Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

c. ASTM D 4060 – Standard Test Method for Abrasion Resistance of Organic Linings by the Taber Abraser

d. ASTM D 4285 – Standard Test Method for Indicating Water or Oil in Compressed Air

e. ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages

f. ASTM D 7682 – Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty

g. ASTM F 2414 – Standard Practice for Sealing Sewer Manholes Using Chemical Grouting

h. ASTM C 1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

3. International Concrete Repair Institute, (ICRI)

a. Guideline No. 310.1R – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion

b. Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealer, Linings, and Polymer Overlays

4. NACE International, (NACE)

a. NACE SP0188 – Standard Practice for Discontinuity (Holiday) Testing of Protective Linings

b. NACE No. 6/SSPC-SP13 – Surface Preparation of Concrete

5. Occupational Safety and health Administration, (OSHA)

a. Safety and health Standards (29 CFR 1910/1926)

6. SSPC: The Society for Protective Coatings, (SSPC)

a. SSPC-SP13/NACE No. 6 – Surface Preparation of Concrete

b. SSPC-Guide 12 – Guide for Illumination of Industrial Painting Projects

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of receipt of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents, the last version of the document before it was discontinued.

1.5 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 entitled “Submittals”, the Contractor shall submit all required information as specified herein.

B. Shop Drawings: Submit for approval prior to commencing any Work:

1. Manufacturer's project reference lists with coating systems specified herein, stating project location, Owner contact information, Engineer contact information, Installer contact information, containing a minimum of 10 projects of similar capacity with a minimum of 5 years of satisfactory service.

2. Product Data Sheets: Copies of current technical data for each component specified and applied as outlined in this Section.

3. Safety Data Sheets: Copies of current SDS for any materials brought on-site including all clean-up solvents, repair or resurfacing mortars and lining materials.

4. Qualification Data: Approved Installer Certification from manufacturer.

5. Performance Testing Reports: Copies of test data for the entire physical, chemical, and permeation properties listed herein and as outlined within this Section.

6. Installation Instructions: Manufacturer's written installation instructions for the materials specified in this Section.

C. Product Substitution: The specified corrosion protection system is the minimum standard of quality for this project. Equivalent materials of other manufacturers may be substituted only by approval of Engineer. Requests for material substitutions shall be in accordance with requirements of the project specification.

1. All Contractors must provide pricing based on the specified system.

2. Manufacturers of "or equal" products shall provide direct property comparison with the materials specified in addition to complying with all other requirements of these Specifications. "Or equal" products shall employ the same generic materials and system components as the Structural Epoxy lining specified and shall provide same intent by description and equivalent performance as the specified Structural Epoxy lining to protect against H_2S corrosion and seal from I&I.

3. "Or equal" products' manufacturer must provide documentation supporting product's success and history in severe wastewater environments for at least ten (10) years; must also provide samples of cured material covering at least one (1) square foot of surface, at the specified thickness; and must provide written repair instruction and a list of materials should a repair be needed in the future.

4. Bidders desiring to use linings other than those specified shall submit proposed system with their proposal at the time of bid, together with the information required herein, and indicate the sum which will be deducted from the base bid should alternate materials be accepted.

D. Job Site Reports: Submit at the completion of Work

1. Daily Reports: Include surface preparation, substrate conditions, ambient conditions application procedures, lining materials applied, material quantities, material batch number(s), description of work completed and location thereof.

2. Quality Control Reports: Include all quality control testing and physical specimens.

3. Contractor shall maintain a copy of records until the expiration of the specified warranty period.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Contractor shall be a certified Applicator by the Structural Epoxy manufacturer prior to bid date. Submit proof of Applicator certification by manufacturer to Engineer.

2. Installation equipment shall be acceptable to the Structural Epoxy manufacturer. If spraying Structural Epoxy, Applicator must utilize equipment approved by Structural Epoxy manufacturer.

3. Applicator shall establish quality control procedures and practices to monitor phases of surface preparation, storage, mixing, application, and inspection throughout the duration of the project. Contractor to provide a full time, on-site person whose dedicated responsibilities will include quality control of the Structural Epoxy linings and completed manufacturing certification training.

4. Applicator's quality control procedures and practices must include the following items:

   a. Training of personnel in the proper surface preparation requirements.

   b. Training of personnel in the proper storing, mixing, and application and quality control testing of the Structural Epoxy linings.

   c. If spraying, training of personnel with the spray equipment to ensure proper film build, film quality, and ratio control.

B. Mock-Ups:

1. At the request of the Engineer and prior to the installation of the Structural Epoxy lining and auxiliary system components, but after Engineer's approval of the Samples and Shop Drawings, install 150 square foot or agreed upon size a stepped-back mock-up of the complete specified lining system showing surface preparation and each system component.

2. The Owner, Engineer, Contractor, Material Supplier and the Applicator shall approve of the mock-up before the start of Work.

3. Retain and protect mock-ups during construction as one standard for judging completed corrosion protection lining Work. Do not alter mock-ups after approval.

4. Contractor shall build as many mock-ups as required to achieve acceptance of the corrosion protection lining.

5. The approved mock-up shall be considered the acceptable minimum standard of quality any corrosion protection lining Work that proceeds without approved mock-ups will not be accepted by the Engineer and removed at no cost to the Owner.

C. Pre-Installation Conference:

1. Before erecting mock-ups Contractor, Installer and technical representative of the corrosion protection lining manufacturer shall meet on-site with Engineer to discuss approved products and workmanship to ensure proper application of the corrosion protection lining components and substrate preparation requirements.

2. Review foreseeable methods and procedures related to the Structural Epoxy lining of coating Work including but not necessarily limited to the following:

a. Review Project requirements and the Contract Documents.

b. Review required submittals, both completed and yet to be completed.

c. Review status of substrate Work, including approval of surface preparations and similar considerations.

d. Review requirements of on-Site quality control testing and requirements for preparing Site Quality Control Report as specified herein.

e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.

f. Review required inspection and testing.

g. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.

h. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.

i. Review procedures required for the protection of the Structural Epoxy lining during the remainder of the construction period.

3. Record the discussions of the Pre-Installation Conference and the decisions and agreements or disagreements reached and furnish a copy of the minutes to each party attending. Record any revision or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

4. Reconvene the conference at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

D. Performance Criteria: Structural Epoxy lining shall be capable of withstanding under constant exposure to raw wastewater, permeation from hydrogen sulfide and other sewer gases, and attack from organic acids generated by microbial sources with no adverse effects; cured film at specified thickness must withstand negative side film forces from inflow and infiltration. Products must have sufficient field history and accelerated laboratory testing to substantiate product viability for these exposures.

E. Source Quality Control: Provide each component of Structural Epoxy lining produced by a single manufacturer, including recommended repair mortar, repair overlay (resurfacer), joint sealant, lining (coating) materials.

F. Reference Standards: Comply with applicable provisions and recommendations of all standards listed in Section 1.2 except as otherwise shown or specified.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:

1. Deliver material in manufacturer’s original, unopened and undamaged packages.

2. Clearly identify manufacturer’s, brand name, contents, color, batch number, and any personal safety hazards associated with the use of or exposure to the materials on each package.

3. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage of Materials:

1. Materials shall be stored in accordance with manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life as defined by the manufacturer shall be removed promptly from the site. Store all materials only in area or areas designated by the Engineer solely for this purpose.

2. Store in original packaging under protective cover and protect from damage.

3. Stack containers in accordance with manufacturer’s recommendations.

C. Handling of Materials: Handle materials in such a manner as to prevent damage to products or finishes.

1.8 JOB CONDITIONS

A. Environmental Requirements:

1. Proceed with Work only when temperature and moisture conditions of substrates, air temperature, relative humidity, dew point and other conditions comply with the Structural Epoxy lining manufacturer's written recommendations and when no damaging environmental conditions are forecasted for the time when the material will be vulnerable to such environmental damage. Record all such conditions and include in final Site Quality Control Report.

2. Maintain substrate temperature and ambient temperature before, during and after installation above 45°F (8°C) and rising in accordance with Structural Epoxy lining material manufacturer's instructions.

3. Provide adequate ventilation during instillation and full curing periods of the Structural Epoxy lining.

4. Structural Epoxy lining shall not be applied when ambient air temperature is within 5°F (3°C) of the dew point.

5. Structural Epoxy lining shall not be applied when relative humidity is outside of material manufacturer's recommendations. Do not prepare surfaces or apply materials in rain, snow, fog, mist, or otherwise inclement weather as per material manufacturer's instructions.

B. Dust and Contaminants: Protect work and adjacent areas from excessive dust and airborne contaminates during Structural Epoxy lining application and curing. Schedule Work to avoid excessive dust and airborne contaminants.

1.9 WARRANTEE

A. Structural Epoxy lining Manufacturer shall warranty its products as free from material defects for a minimum period of five (5) years. Provide associated Warranty Certificate.

B. Contractor shall warranty the installed Structural Epoxy lining system as free from workmanship defects for a minimum period of five (5) years.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Products and Manufacturer:

1. Materials specified are those that have been evaluated for the specific service. Products of Epoxytec LLC (a Tnemec company, www.tnemec.com, +1-800-863-6321) www.epoxytec.com are specified as a standard of quality and basis of design. The specified basis of design is intended to provide the longest service life possible, lowest life cycle cost, and most sustainable solution. All Contractors must provide pricing based on the the specified system in the Base Bid.

2. Or Engineer Approved Equal. Materials specified herein shall not preclude consideration of equivalent or superior materials. Alternate materials shall include the following:

    a. Shown in the Bid Schedule as Additive Bid Item as an ADD or DEDUCT to overall Base Bid.

    b. Completion of Appendix A of this Section. The burden of proof of performance equality is the responsibility of the Party requesting a substitution in materials. Standardized industry test methods in Appendix A shall be used in part for comparison.

    c. Materials must have a proven track record of successful installation. Provide Manufacturer's project reference lists with coating systems specified herein stating project location, Owner contact information, Engineer contact information, Installer contact information, containing a minimum of 10 projects of similar capacity with a minimum of 5 years of satisfactory service.

    d. The owner will decide which Bid Item to accept.

3. Contractor shall provide all accessory components, as specified or recommended by the manufacturer for optimal application of the Structural Epoxy lining system's adhesion to substrate and long-term service performance.

4. Chemical Grout:

    a. Depending on the specific application Urethane Based Grout shall be furnished. The type of grout to be used shall be in accordance with the manufacturer's recommendation for the specific application area of the project. Chemical grout sealant solution containing principal chemical sealant constituent, initiator (trigger) and catalyst specifically recommended for the purpose of sealing leaks in manholes. Chemical sealant constituent, initiator (trigger) and catalyst shall be compatible when mixed. Solution shall have ability to tolerate dilution and react in moving water. After final reaction, it shall be a stiff, impermeable, yet flexible gel. The grout proportions shall be such that dilute aqueous solutions, when properly catalyzed will form stiff gels. Materials provided shall gel in a predetermined time period when exposed to normal groundwater pH ranges, and be capable of formula adjustments to compensate for changing conditions. Final reaction shall produce a continuous, irreversible, impermeable stiff Gel and shall not be rigid or brittle. The cured material must be impervious to water penetration and withstand submergence in water, without degradation and must not be biodegradable.

5. Cementitious Repair Mortar:

    a. Rapid-setting, cementitious repair mortar when concrete is deteriorated greater than a depth of 1/2-inch (12.7 mm) and when recommended by

the Manufacturer to rehabilitate and restore concrete, grouting of joints and provide level substrate for application of the protective lining. Cementitious repair mortar shall be a rapid-setting, non-shrinking resurfacing material capable of spray-transfer. Material shall have similar CLTE properties as concrete.

6. Epoxy Cementitious Resurfacer:

   a. Epoxy cementitious resurfacer shall be an epoxy-modified, aggregate reinforced material with for surfacing, patching and filling voids and bugholes in concrete. The material shall be suitable for the application down to 1/16 inch (1.6 mm) thickness and be capable of spray-transfer.

   b. Epoxy cementitious resurfacer shall exhibiting high bond strength and high mechanical strengths. Initial set time occurs early (4 hours @ 77F) to allow for Structural Epoxy coating. The Epoxy cementitious resurfacer shall not require for any further preparation or conditioning within 36 hours (at 77F) to accept epoxy top coats.

7. Structural Epoxy Lining:

   a. Structural Epoxy shall be available in both trowel-version and spray-version to assist with various application needs or applications in limited access areas or perform any touch-ups.

   b. Structural Epoxy shall be 100% solids, highly thixotropic microfiber-reinforced, applied epoxy polycyclic polymer protective barrier material specifically designed to protect concrete and masonry surfaces in severe wastewater environments, including H2S attack, while sealing inflow and infiltration (I&I).

   c. Structural Epoxy is to provide protection from H2S corrosion and seal from I&I with applied and bonded high build Structural Epoxy; Structural Epoxy film thickness specified herein is designed and intended for applied and bonded coating, delivering barrier protection lining with high mechanical strength and a reinforced film to bridge and seal against moisture vapor transmission (MVT), hydrostatic head pressure, fine root intrusion, and seal inflow and infiltration (I&I).

   d. Structural Epoxy lining must be a verified technology of US Environmental Protection Agency's, Environmental Technology Verification Program for Infrastructure Rehabilitation Technologies (EPA ETV).

   e. Structural Epoxy lining shall be capable of achieving up to 375 mil. (3/8 inch) sag resistance, vertical and overhead.

   f. Structural Epoxy lining must have a long open recoat window without the need for abrasive or mechanical preparation for simple repair requirements.

g. Structural Epoxy lining must be self-priming, able to be applied direct-to-concrete (DTC), requiring no primer.

h. Structural Epoxy lining must be able to bond to saturated-surface-dry (SSD) concrete, with moisture and relative humidity tolerances up 85% and capable to fully cure underwater.

8. Manhole Chimney Joint Sealant:

a. Manhole chimney joint sealant is an applied polymer elastomer designed to prevent leakage of water into the manhole through the frame joint area and the area above the manhole cone including all extensions to the chimney area. Extensions shall include but are not limited to lifting rings, brick and/or block material that may have been used to achieve grade. The polymer chimney seal material shall be corrosion resistant to H2S. The sealing system shall line the interior of the adjustment area from the cone/top of the manhole and onto the inside of the casting.

PART 3 - EXECUTION

3.1 GENERAL

A. All work shall be in strict accordance with the specifications and recommendations including mixing, handling, storage, and application of all products as required and in accordance with manufacturer's published technical instructions, safety data sheets, including manufacturer's published PDS, design guidelines, and/or other written specifications.

B. Contractor shall provide, erect, and maintain all required hoists, scaffolding, staging and planking, and perform all access related hoisting work required to complete the Work of this Section as specified.

C. Contractor shall cover or otherwise protect finish work or other surfaces not being coated within the scope of this Section. Contractor shall erect and maintain protective tarps, enclosures and/or masking to contain debris, including dust or other airborne particles from surface preparation or application activities. This may include the use of dust or debris collection apparatus as required at no additional cost to Owner.

3.2 EXAMINATION

A. Contractor shall examine the areas and conditions under which the Structural Epoxy coating Work is to be performed in accordance with SSPC-SP13/NACE No. 6, and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work.

B. Commencement of the Work of this Section shall indicate that the substrate and other conditions of installation are acceptable to the Contractor and his Applicator and will produce a finished product meeting the requirements of the

Specifications. All defects resulting from accepted conditions shall be corrected by Contractor at his own expense.

C. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, coating installation should be scheduled when the temperatures are falling versus rising.

3.3 PREPARATIONS

A. Concrete surfaces to receive Structural Epoxy coating shall be cast with a Smooth Form Finish in accordance with ACI 301. Surfaces shall not be rubbed, sacked, troweled or otherwise finished in any manner that will obscure or cover the parent concrete surface with materials other than materials as specified in this Section.

B. All surface washing, abrasive blasting, waterjetting, grinding, patching, filling and preparation shall be completed by the Applicator in accordance with the Structural Epoxy lining Manufacturer's recommendations.

C. Substrate: Concrete surfaces to be coated shall be free of curing compounds and form release agents, laitance and foreign particles that may inhibit bonding. Prior to start of Structural Epoxy coating systems application, pre-clean as required, and inspect the substrate in accordance with SSPC-SP13/NACE No. 6, Severe Service. Surface preparation procedures shall be in accordance with NACE No. 6/SSPC-SP13 and ICRI Guideline No. 310.2. Surface preparation shall expose aggregate and obtain a uniform surface texture resembling the minimum recommended concrete surface ICRI-CSP 5 profile.

D. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of all sharp edges, ridges, form fins, and other concrete protrusions.

E. Surface preparation of the substrate must be achieved immediately prior to utilizing any repair material and/or coating/lining material that will require bond to the substrate, re-inspection and/or subsequent surface preparation may need to be repeated should conditions change after initial preparation.

F. Surface preparation will be required on existing and new concrete.

G. The objective of surface preparation is to produce a surface that is suitable for application and adhesion of the specified repair materials and coating/lining material. Surfaces therefore are to be free of contaminants and loosely adhering or unsound concrete, and should provide a dry, sound, uniform substrate suitable for the application of repair and coating/lining material.

H. Structures to receive Structural Epoxy lining system must be capable of withstanding imposed loads. All oil, grease, waste and chemical contaminants must be removed from the surface of the concrete prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the Structural Epoxy Lining system as determined by the engineer. Surface preparation requirement is to expose a sound, uniform surface texture confirming to the minimum recommended ICRI-CSP 5. The appropriate cementitious repair mortar or epoxy cementitious resurfacer material shall be applied to the entire, prepared surface to level surface suitable for coating.

I. Metal Application: Remove all visible contaminants per SSPC-SP1. Prepare the surfaces in accordance with SSPC/NACE surface preparation standards per the Manufacturer's instructions.

3.4 APPLICATION

A. Structural Epoxy lining systems shall be installed when ambient air and surface temperature is above 45°F. The substrate temperature shall be at least 5°F (3°C) above the dew point. Condition the material between 70-80°F (21-27°C) for 24 hours prior to use. Application when temperatures outside of this range will require written instruction from the Manufacturer and approval of the Engineer.

B. Application in direct sunlight and/or with rising surface temperatures is not advised, as this may result in blistering of the materials due to expansion of entrapped air or moisture in the concrete (induced outgassing). In such cases, it will be necessary to postpone the application until later in the day when the temperature of the substrate is falling or take precautionary steps as recommended by the Manufacturer. Concrete surfaces that have been in direct sunlight should be shaded for at least 24 hours prior to application. Consult the Manufacturer for application schedule guidelines specific to temperature conditions and possible sealer application recommendations to reduce outgassing.

C. Chemical Grout: Sanitary sewer grade chemical grouts shall be urethane-based, and formulated specifically for use in grouting pre-cast barrel joints, brick and CMU structures, and/or pipe penetrations and pinholes to stop aggressive flowing leaks.

1. Cure – Mixing and handling of all the chemical grout materials shall be in accordance with chemical grout manufacturer's recommendations. Application of materials shall be by injection method according to chemical grout manufacturer recommendation and industry defined standard ASTM F 2414, using appropriate pressure to ensure no damage to the structure.

2. Re-Blast - All excess chemical grout must be removed from the surface by mechanical means.

D. Cementitious Repair Mortar: Epoxytec Mortartec Silicate or Tnemec Series 217 MortarCrete cementitious repair mortar shall be used for structural repairs or surface repairs exceeding a depth 1/2 inch (12.7 mm) in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Minimum ½ inch as required to re-establish original plane.

2. Cure – Ensure that the mortar while curing will remain moist, covered from direct sunlight, and if needed, covered by damp coverings to avoid mortar dry-out and to optimize curing.

3. Re-blast – Clean and profile the surface to remove the laitance layer and to uniformly profile the surface to produce a minimum ICRI CSP 6 surface profile amplitude.

E. Epoxy Cementitious Resurfacer: Epoxytec Mortartec Ceramico epoxy cementitious resurfacer shall be used for filling voids, bugholes, static cracks and joints, and for general concrete patching, and to provide a uniform, void free surface for Epoxy Lining application,

1. Thickness – Epoxy lining shall be applied to a minimum thickness of 1/16 inch (1.6 mm) to the entire surface.

2. Cure - Ensure that the mortar while curing will remain moist, covered from direct sunlight, and if needed, covered by damp coverings to avoid mortar dry-out and to optimize curing

F. Structural Epoxy Lining: Epoxytec CPP Sprayliner MH or Epoxytec CPP Trowel-Liner epoxy lining. Structural Epoxy coating shall be applied and in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Epoxy lining shall be applied to a minimum thickness of 125 mils (1/8" inch) dry film thickness.

G. Manhole Chimney Joint Sealant: Applied polymer elastomer sealant, Epoxytec Uroseal 45V shall be applied and in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide. Applied polymer elastomer material is applied after Structural Epoxy lining material is installed and cured.

1. Thickness – Manhole chimney joint sealant shall be applied to a minimum thickness of 250 mils (1/4" inch) dry film thickness.

2. Re-blast – Lightly abrade and clean the surface of the Structural Epoxy liner when applying manhole chimney joint sealant beyond the recoat window of the Structural Epoxy.

3.5 FIELD QUALITY CONTROL, INSPECTION AND TESTING

A. Contractor to perform the quality control procedures listed below in conjunction with the requirements of this Section.

B. Inspect all materials upon receipt to ensure that all are supplied by the approved Manufacturer.

C. Surface pH Testing: The pH of substrate will be measured using pH indicating paper or pH meter. Acceptable pH values shall be a minimum 9.0 as measured using color indicating pH paper with readable color calibrations and a scale at whole numbers or pH meter.

D. Surface Profile: Inspect and record substrate profile (anchor pattern) at least once every 5 vertical feet or every 100 square feet (9.3 square meters). If

applying Structural Epoxy direct-to-concrete (DTC), surfaces shall be profiled equal to the CSP 5 amplitude as recommended by the coating manufacturer in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6; for Cementitious Repair Mortar work, surfaces shall be profiled equal to the CSP 6.

E. Provide verification of correct mixing of coating materials in accordance with the Manufacturer’s instructions.

F. Inspect and record that the "pot life" of coating materials is not exceeded during installation.

G. Verify curing of the coating materials in accordance with the Manufacturer's instructions.

H. Dry-Film Thickness:

1. Wet-Film Thickness shall be taken every two vertical feet (2 vf) or every 25 square feet (2.3 square meters) in accordance with ASTM D 4414 and recorded.

2. The Dry-Film Thickness can be determined using a surface area calculation for material consumption.

I. High-Voltage Holiday (Spark) Testing: Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE SP0188 and the Manufacturer’s printed application guide to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner.

J. Contractor is responsible for keeping the Engineer informed of all progress so that Engineer may provide additional quality control at his discretion.

K. Inspection by the Engineer or others does not absolve the Contractor from his responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

3.6 ACCEPTANCE CRITERIA:

A. All surfaces shall be prepared, applied, and tested in accordance with the specification and referenced standards herein.

B. Where specified if the entire manhole including invert and pipe penetrations is rehabilitated monolithically then a Vacuum Test may be performed according ASTM F 1244. If vacuum test fails then the contractor shall spray entire manhole with a soap solution and retest to determine where air is entering the manhole. Inspector shall determine if failure was due to improper rehabilitation or poor pipe condition or improperly seated plugs. If inspector determines that the failure is due to improper rehabilitation then the Contractor shall repair manhole according to manufacturer recommendations and retest until a successful vacuum test is achieved. If inspector determines that the failure was due to poor condition of the pipes, or annular space between the pipe and its liner, or the inability to seat the plugs properly and that there are no visible defects in the applied product then it will be determined that the manhole has passed.

3.7 ADJUSTMENTS AND CLEANING:

A. At the completion of the Work, Contractor shall remove all materials and debris associated with the Work of this Section.

B. Clean all surfaces not designated to receive Structural Epoxy coating. Restore all other work in a manner acceptable to Engineer.

C. All finished Structural Epoxy coating shall be protected from damage until Final Acceptance of the Work. Structural Epoxy coating damaged in any manner shall be repaired or replaced at the discretion of Engineer, at no additional cost to Owner.

+ + END OF SECTION + +

SECTION 10 14 00

IDENTIFICATION SIGNS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install identification signs.
   2. Extent of identification signs is shown on the Drawings and, where indicated, as specified.
   3. Types of products required include the following:
      a. Self-luminous exit signs.
      b. Room identification, information, entry and directional signs.
      c. Health, safety, warning, floor loading and fire extinguisher location signs.
      d. Right-to-know labels, signs and tags.
      e. Cast metal dedication plaque.
      f. Exterior building identification signs.
      g. Site entry, directional and information signs.
      h. Individual dimensional letters and numbers.
      i. Stainless steel fasteners, supports, very-high-bond high-performance mounting tape, primers and other accessories.
      j. Vehicle Idling Restriction

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the identification signs.
   2. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections in order to insure compatibility of identification sign mounting accessories for the various surfaces.

1.2 QUALITY ASSURANCE

A. Identification Sign Manufacturers:
   1. Engage firms specializing in the production of the types of products specified, in compliance with specified standards, with a documented record of successful in-service performance, and who can provide sufficient production capacity to avoid delaying the Work.
   2. Submit name and experience record of manufacturers to ENGINEER.

B. Source Quality Control:

   1. Obtain each separate type of identification sign from a single supplier and from a single manufacturer.
   2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.

C. Performance Criteria:
   1. Details for identification signs shown on the Drawings, such as alphabet representation, letter spacing, borders designs, and other graphic features, are generic and intended to establish text, general positions and symbols only.
   2. Submit for approval complete, camera-ready, color graphic layouts based on specified requirements and recommendations from manufacturer.

D. Allowable Tolerances:
   1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16-inch measured diagonally.

E. Requirements of Regulatory Agencies:
   1. Permanent rooms and spaces, and directional and informational signage where specified as accessible to people with disabilities shall comply with ANSI A117.1 and ADAAG.
   2. Where identification signs are specified as accessible to people with disabilities provide text, with alphabet both in English and Grade 2 Braille on each accessible room identification, informational and directional sign, and with color and contrast, mounting heights and other features as required to comply with the Americans with Disabilities Act of 1990 Appendix A to Title 28 Code of Federal Regulations Part 36 Accessibility Guidelines for Buildings and Facilities (ADAAG), latest edition.
   3. All right-to-know labels, signs and tags shall use NFPA 704 “Diamond” hazard identification systems and shall comply with OSHA 1910.1200 and OSHA Subpart Z.
   4. All accident prevention signs and tags shall comply with OSHA 1910.145.
   5. All health, safety and warning signs shall comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3 and OSHA 1910.144 and 1910.145, unless otherwise specified. The colors shall be those of opaque glossy samples as specified in Table 1 of ANSI Z535.1. Safety symbol pictograms shall be incorporated into each sign, in addition to text.
   6. Vehicle Idling Restriction, U.S Code of Federal Regulation 49 CFP Park 395 and the Arizona Department of transportation (DOT) regulation R17-5-202.

F. Codes: Comply with the Phoenix Building Code.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   2. ASTM B 26, Specification for Aluminum-Alloy Sand Castings.
   3. ASTM B 584, Specification for Copper Alloy Sand Castings for General Applications.
   4. ASTM E 527, Practice for Numbering Metals and Alloys (UNS).
   5. ANSI A13.1 Scheme for the Identification of Piping Systems.
   6. ANSI A117.1, Accessible and Usable Buildings and Facilities.
   7. ANSI Z535.1, Safety Color Code.
   8. ANSI Z535.2, Environmental and Facility Safety Signs.
   9. ANSI Z535.3, Criteria for Safety Symbols.
   10. ANSI Z535.4, Product Safety Signs and Labels.

11. ANSI Z535.5, Accident Prevention Tags (for Temporary Hazards).
12. NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
13. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.1200, Hazard Communication Standard.
14. OSHA 1970, Title 29, Code of Federal Regulations Part 1910, Subpart Z, Toxic and Hazardous Substances.
15. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.144, Safety Color Code for Marking Physical Hazards.
16. OSHA 1970, Title 29, Code of Federal Regulations Part 1910. 145, Specification for Accident Prevention Signs and Tags.
17. Public Law 101-36, The Americans with Disabilities Act of 1990, Title 28, Appendix A, Code of Federal Regulations Part 36, Accessibility Guidelines for Buildings and Facilities - ADAAG.
18. Chemical Abstracts Service, CAS Registry Numbers for Specific Chemical Identity.
19. Copper Development Association, CDA, Properties of Cast Copper Alloys.
20. The Aluminum Association, AA SAA-46, Standards for Anodized Architectural Aluminum.
21. The Aluminum Association, AA DSA-45, Designation System for Aluminum Finishes.
22. Vehicle Idling Restriction, MCAQ Ordinance P-21

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each color and finish of exposed materials and accessories required for identification devices
   2. Actual full-size sample of each type of permanent room and space identification sign and informational and directional sign incorporating all features specified; pipeline identification sign and mounting accessories; structure nameplate, valve tags and accessories; and right-to-know signs, labels and tags. Information on the type of coding system will be furnished to CONTRACTOR by ENGINEER.
   3. Actual full-size representative sample of each individual-type letter and number specified, demonstrating alphabetic style, material, color and finish specified.
   4. ENGINEER'S review of samples will be for color and texture only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical data for each product specified including fabrication and erection information for all identification signs. Show anchorages and accessory items. Furnish location template drawings for items supported or anchored to permanent construction.
   2. Complete selection of each specified manufacturer's standard and custom colors, alphabetic styles, graphic layouts and pictograms. Include full-size graphic layouts for plaques, individual dimensional letters and numbers and other items where final graphic appearance must be established prior to

fabrication, incorporating all required graphic features specified or shown on the Drawings.

3. Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on Drawings showing locations of all required exit signs based on measurements taken at the site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other work and as required by the OWNER.
4. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

1.4 PROJECT CONDITIONS

A. Field Measurements:
   1. Verify dimensions in areas of installation. Take measurements at the site before fabrication and indicate dimensions on Shop Drawings. Coordinate fabrication schedule with Progress Schedule to avoid delaying the Work.
   2. Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to dimensions established for identification devices Work.

B. Scheduling:
   1. Coordinate the delivery of templates, instructions and directions for installation of anchorage devices with other Work to avoid delay.

1.5 MAINTENANCE

A. Extra Materials:
   1. Furnish extra materials from the same manufactured lot as the materials installed.
   2. Provide the following spare parts and accessories:
      a. For every 20 pipeline identification signs installed:
         1) One complete mounting assembly.
      b. For every 20 nameplates installed:
         1) One complete nameplate mounting assembly.
      c. For every 20 No Trespassing signs installed:
         1) Five additional signs.
   3. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened and undamaged containers and packages; with legible labels accurately representing contents of container or package indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
      a. All spare parts and accessories shall be suitably boxed and marked for storage and reordering.

B. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used on this Project, with calculations establishing quantity of extra materials to be furnished to OWNER.

PART 2 - PRODUCTS

2.1 SELF-LUMINOUS EXIT SIGNS

A. Provide self-luminous exit signs with single and double face dimensions of 7-5/8 inches by 11-3/4 inches by 2 inches deep. Sign housing shall consist of engineering-grade thermoplastic that is impact resistant, scratch-resistant, and corrosion proof with UL94V-0 flame rating. The size, graphics and background colors of the sign legend shall conform to all relevant code requirements.

B. Lumination for exit signs shall be red LED type.

C. Signs shall be listed by Underwriters Laboratories as being capable of providing a 15-year service life.

D. Provide manufacturer's standard universal mounting brackets, extended wall and ceiling mounting brackets, pendant mounting brackets and recessed mounting brackets as mounting surface and exiting conditions require, or as shown.

E. Product and Manufacturer: Provide one of the following:
   1. Contractor Select LQM Quantum LED Emergency Exit by Lithonia Lighting.
   2. Or equal.

2.2 ROOM IDENTIFICATION, INFORMATION, ENTRY AND DIRECTIONAL SIGNS

A. Product Description: Provide unframed signs, surface-etched, 1/32-inch raised tactile lettering and pictograms, sandblasted on an opaque 3-ply laminate of self-extinguishing melamine plastic sheet with a non-glare surface and phenolic core.

B. Size and Thickness: 0.125-inches thick; 8-inches by 8-inches with 1/2-inch radiused corners.

C. Exposure: Recommended by the manufacturer for interior and non-direct sun exterior use and acceptable for continuous operating temperatures of 225°F.

D. Graphics and Alphabet: White, Standard Helvetica Medium alphabet and matching arrow type-face; upper and lower case 1-inch high capitals and, in addition, Grade 2 Braille alphabet for room designation, directional, entry and information signs.

E. Colors and Contrast: Background of signs shall be eggshell, matte or other non-glare finish. Characters and symbols shall contrast by at least 70 percent with their background as determined by ADA formula in ADAAG Appendix A4.30.5.

F. Product and Manufacturer: Provide one of the following:
   1. Graphic Blast HC-200 ADA System and Custom Design ADA Series by Best Manufacturing Sign Systems, Incorporated.
   2. Or equal.

2.3 HEALTH, SAFETY, WARNING, FLOOR LOADING AND FIRE EXTIN-GUISHER LOCATION SIGNS

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Size and Thickness: 0.125-inches thick; 10-inches by 14-inches, unless otherwise specified.

C. Graphics and Alphabet: Standard Helvetica Medium alphabet and matching arrow typeface, upper and lower case 1-inch high capitals and, in addition, Grade 2 Braille alphabet message designations and other text.

D. Exposure: Recommended by the manufacturer for both indoor and outdoor use and with an upper service temperature limit of 190°F. Average durability for outdoor use shall be 15 years.

E. Safety Instruction Signs: Standard color of the background shall be white; and the panel, green with white letters. All letters used against the white background shall be black.

F. Caution Signs: Standard color of the background shall be yellow; and the panel, black with yellow letters.

G. Danger Signs: Standard color of the background shall be white; and the panel black with red insert containing white letters. All letters used against the white background shall be black.

H. Warning Signs: Standard color of the background shall be orange; and the panel black with orange insert containing black letters. All letters used against the orange background shall be black.

I. No Smoking Signs: Standard color of the background shall be white. All letters used against the white background shall be red.

J. Biohazard Signs: Standard color of the background shall be white; and the panel black with white letters. Incorporate red international biohazard pictogram on white background.

K. Floor Loading Signs: Standard color of the background shall be white; and the panel blue with white letters. All letters used against the white background shall be black.

L. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of the background shall be red with white letters. Each sign shall incorporate an international fire extinguisher pictogram and a directional arrow indicating location of fire extinguisher.

M. Auxiliary Products:
   1. Mounting Brackets: Provide manufacturer’s standard mounting brackets for hanging, projected or double-sided signs.

N. Product and Manufacturer: Provide one of the following:
   1. Graphic Blast Word and Picture Series by Best Manufacturing Sign Systems, Incorporated.
   2. Or equal.

2.4 PIPELINE IDENTIFICATION SIGNS

A. Pipeline Identification Signs:
   1. Lettering of Titles:
      a. Letter size shall be as indicated in the following table:

LETTER SIZE TABLE

Outside Diameter of Pipe or Covering*	Size of Legend Letters
3/4-inches to 1-1/4 inches	1/2-inches
1-1/2-inches to 1-7/8-inches	3/4-inches
2-inches to 5-7/8-inches	1-1/4-inches
Outside Diameter of	
6-inches to 9-7/8-inches	2-1/2-inches
10-inches and Over	3-1/2-inches

*Outside diameter shall include pipe diameter plus insulation and jacketing.

      b. Text and symbols shall be Standard Helvetica Medium, all upper case. Signs shall include text with separate arrow signs indicating direction of flow and be located as specified in Part 3 of this Section.
   2. Sign Materials: Provide the following:
      a. Signs shall be coiled construction, polyester with ultraviolet light resistant, sealed, subsurface color graphics, recommended by the manufacturer for both indoor and outdoor use and for service temperature range from -40°F to 248°F.
      b. Provide manufacturer's full selection of standard and custom sizes, colors and graphics. Where manufacturer has established minimum order quantities for custom units provide minimum order quantities at no additional expense to OWNER.
      c. Where large pipe diameters preclude overlap of pipeline sign material, provide Type 304, 1/4-inch wide stainless steel banding straps; two per sign, lengths as required by circumference of pipe or covering. Provide manufacturer's recommended banding tools for stainless steel banding.
   3. Product and Manufacturer: Provide one of the following:
      a. Custom B-689 High Performance Pipe Markers by Brady USA, Incorporated Signmark Division.
      b. Or equal.

2.5 PIPELINE MARKERS

A. General:

1. Pipelines over 3/4-inch outside diameter: Provide painted pipeline markers.
2. Each marker shall consist of at least one legend descriptive of the function of the pipe, and a directional arrow.
3. The size of lettering and marker shall conform to ANSI A13.1.
4. Location of Markers:
   a. Adjacent to each valve and “T” connection.
   b. At each branch and riser takeoff.
   c. At each pipe passage through a wall, floor and ceiling.
   d. On all horizontal and vertical pipe runs at 25-foot intervals.

2.6 VALVE AND PIPELINE TAGS

A. Metal Tags:
   1. For all valves and pipelines smaller than 3/4-inch in diameter provide permanently legible metal tags, 2-inch diameter round, Type 304 stainless steel tags with engraved lettering filled with black enamel. Provide all valve tags with a 3/16-inch diameter hole located so as not to interfere with legend.
   2. Legend for Valve Tags:
      a. Based on information provided on the Drawings, submit to ENGINEER, no less than 150 days before start-up, a valve schedule containing all required valves.
      b. The schedule shall contain for each valve, the location, type, a number, and words to identify the valve’s function, type of operator and the normal operating position.
      c. Information contained in the valve schedules shall be coded on the tags in a system provided by OWNER. Each valve shall be coded and identified by ENGINEER utilizing a combination of up to twelve letters and numbers.
   3. Miscellaneous Valve and Small Pipeline Tag Accessories:
      a. Stainless Steel Wire: Nylon coated; outside diameter 0.048-inches.
      b. Clamps: Brass.
      c. Lead Seals: Monel; 4 ply, 0.014-inches by 10-inches long; for attaching all tags.
      d. Hand Sealing Press: As recommended by tag manufacturer for crimping lead seals.

B. Product and Manufacturer: Provide one of the following:
   1. Custom Engraved Stainless Steel Valve Tags by Brady USA, Incorporated, Signmark Division.
   2. Or equal.

2.7 RIGHT-TO-KNOW LABELS, SIGNS AND TAGS

A. Tank Signs:
   1. Provide quantity of signs shown on the Drawings, identifying the chemical, it’s hazards, required protective equipment in text and pictograms, first aid for eyes, skin, ingestion and inhalation, information on confined space entry and NFPA 704 required hazard rating system information.
   2. Right-to-know fiberglass signs for storage tanks shall have pressure sensitive adhesive backs and shall be provided with subsurface numbers, symbols, text and legends. Labels shall provide chemical name and chemical abstracts

service number, fire and health hazard potential, reactivity, personal protection and target organ legends in compliance with NFPA 704 format and OSHA 1910.1200.

B. Labels: Provide right-to-know polyester labels for each hazardous chemical container. Provide 7-inch by 10-inch labels with information pre-printed by manufacturer. Provide labels with two mil polyester over laminate and with a complete line of all standard and custom pictograms.

C. Tags: Provide right-to-know 15 mil vinyl tags with self-adhering clear polyester over laminate. Tags shall be constructed of laminated plastic and furnished with nylon tie fasteners. Provide 3-inch by 5-3/4-inch tags with two chamfered corners with reinforced 3/16-inch grommet hole.

D. Product and Manufacturer: Provide one of the following:
   1. Custom B-302 Pressure Sensitive Polyester Right-To-Know Labels, B-120 Fiberglass Chemical Tank Signs, Front No. 1/Back No. 1 B-871 Right-To-Know Accident Prevention Tags and Right-To-Know Pictograms by Brady USA, Incorporated Signmark Division.
   2. Or equal.

2.8 EXTERIOR BUILDING IDENTIFICATION SIGNS

A. Material: Provide surface-etched, lettering and pictograms, sandblasted on an opaque 3-ply laminate of 1/4-inch thick flat 3-ply glass-reinforced resin sheet with a non-glare surface and contrasting color core acceptable for continuous operating temperatures of 190°F.

B. Alphabet and Graphics: Coordinate with OWNER for selection of alphabet and graphics.

C. Product and Manufacturer: Provide one of the following:
   1. Graphic Blast Wall Mounted Signs by Best Manufacturing Sign Systems, Incorporated.
   2. Or equal.

2.9 INDIVIDUAL DIMENSIONAL CAST LETTERS AND NUMBERS

A. Provide individual cast metal letters and numbers with smooth, flat faces, sharp corners, true lines and accurate profiles.

B. Material: Bronze, Copper Development Association Designation Alloy, UNSC83450; 88 percent copper, 2.5 percent tin, 2 percent lead, 6.5 percent zinc and 1 percent nickel, as designated by ASTM E 527; with dark statuary bronze oxidized CDA-M31C5506x finish produced by an aqueous sulfide conversion chemical.
   1. Provide all letters and numbers with both faces and edges with a satin finish.
   2. Provide integral cast lugs in the back of letters and tap to receive threaded mounting studs.

C..

E. Product and Manufacturer: Provide one of the following:
   1. Cast Bronze Individual Letters and Numbers by Gemini Incorporated.
   2. Or equal.

2.10 SITE ENTRY, DIRECTIONAL AND INFORMATION SIGNS

A. Fiberglass sheets, 1/8-inch thick minimum, bonded to an extruded aluminum internal structure, to form a seamless monolithic sign panel. Provide the following:
   1. Posts: 4-inch diameter 6063-T52 alloy extruded aluminum round posts notched to receive sign panel. Provide posts height of 6 foot-0 inches above finished grade.
   2. Finish: Two coats of colored polyurethane and one coat of clear polyurethane; factory applied to posts and sign panels. Provide complete selection of manufacturer's standard and custom colors.
   3. Graphics: Subsurface, photo-mechanically incorporated utilizing an integral graphic process
   4. Color: ENGINEER may select a maximum of three colors, in addition to white and black. All three colors and city logogram, in addition to white and black, will appear on each sign.
   5. Letter Style: Coordinate with OWNER for selection of letter style. Coordinate directional arrows with selected letter style.

B. Product and Manufacture: Provide one of the following:
   1. 821 FR Series by ASI Sign Systems, Incorporated.
   2. Custom Site Signs by Andco Industries Corporation.
   3. Or equal.

2.11 EXTERIOR SITE, NO TRESPASSING SIGNS

A. Material: Flat aluminum sheet with reflective surface. Large enough to contain the below message. Lettering to be centered on sign.

B. The size of the sign, and size of the lettering will depend on the location, the standard color will be black letters on a silver background. Size of sign shall be 30" x 24.

C. The signs will read as follows:

CITY OF PHOENIX PROPERTY
Water Services Department

NO TRESPASSING
Authorized Personnel Only

Per ARS 13-1501 & 13-1504
Trespassing on this site is a Class 5 Felony
Violators will be prosecuted

This property is protected by 24 hour
Electronic Surveillance Monitoring

2.12 EXTERIOR SITE, DANGER SIGNS

A. Material: Flat aluminum sheet 20 gauge with white background.
B. All chemical signage (hazard diamond) shall be in accordance to the latest revision of the NFPA 704 – Standard System for the Identification of the Hazards of Materials for Emergency Response

2.13 FIRE LANE SIGNS

A. Material: Flat aluminum sheet 20 gauge with a reflective background. Large enough to contain the below message. Lettering to be centered on sign.

FIRE
LANE

NO
PARKING

BY ORDER OF THE
FIRE MARSHALL

PHOENIX FIRE CODE

C. The size of the sign, and size of the lettering will be per Phoenix Fire Code, the standard color will be red letters on a silver background.

2.14 NOTICE OF SECURITY ALARM SIGN

A. Material: Flat aluminum sheet 20 gauge with white background. Large enough to contain the below message. Lettering to be centered on sign.

NOTICE

SECURITY ALARM
WILL SOUND IF
DOOR IS OPENED

B. The size of the sign, and size of the lettering will depend on the location, the standard color will be black letters on a white background. Coordinate with OWNER exact size of the sign.

2. 15 NO SMOKING EXTERIOR SIGN

A. Material: Flat aluminum sheet 20 gauge with white background.
B. Sign shall have the International No Smoking Symbol. Sign will be on a white background. Coordinate with OWNER exact size of the sign.

2.16 SITE DESIGNATION EXTERIOR SIGN

A. Material: Flat aluminum sheet 20 gauge with a white background. Large enough to contain the below message. Lettering to be centered on sign.

CITY OF PHOENIX

LIFT STATION 40

5102 EAST RAY RD

EMERGENCY: (602) 261-8000

B. The size of the sign, and size of the lettering will depend on the location, the standard color will be black letters on a white background. Coordinate with OWNER exact size of the sign and PWS NO.

2.17 VEHICLE IDLING RESTRICTION SIGNS

A. Facilities with a loading dock shall install the required signs at the site entrance and at the loading dock.

B. Material: Flat aluminum sheet with reflective surface, the standard color will be black letters on a silver background and large enough to contain the below message. Lettering to be centered on sign.

C. The size of the sign must be 12 inches by 18 inches.

D. The sign must have a maximum idle time.

E. The sign must have the Maricopa County Vehicle Idling information line telephone number.

F. The sign must have the amount of money the violator will be fined.

G. The sign will read as follows:

THE MAXIMUM IDLE TIME ALLOWED IN
MARICOPA COUNTY IS FIVE MINUTES.
MARICOPA COUNTY VEHICLE IDLING
INFORMATION LINE
602-372-0972

THE OWNER OR OPERATOR OF THE
VEHICLE WHO VIOLATES THIS ORDINANCE
IS SUBJECT TO A MINIMUM CIVIL PENALTY
OF $100 FOR THE FIRST VIOLATION AND
$300 FOR A SECOND AND ANY
SUBSEQUENT VIOLATIONS

2.18 AUXILIARY MATERIALS

A. Very-High-Bond High-Performance Bonding Tape:
   1. Provide all surface-mounted identification devices with very-high-bond foam tape backing except where specifically specified as requiring mechanical fasteners.

2. Provide a very-high-bonding pressure sensitive joining system consisting of double-coated conformable acrylic foam tape and release liners:
3. Thickness: 0.045-inch.
4. Tape Width: 1-1/2-inches.
5. Color: Dark grey.
6. Bonding Adhesive: Acrylic; very-high-bond, solvent and shear resistance.
7. Primer: High-performance tape manufacturer's recommended acrylic primer.8. Product and Manufacturer: Provide one of the following:
   a. Scotch Brand (Very-High-Bond) 4942 VHB Double Coated Acrylic Foam Tape and No. 94 Acrylic Primer by 3M Industrial Tape and Specialties Division.
   b. Or equal.

B. Mounting Brackets: Provide manufacturer's standard mounting brackets for hanging, projected or double-sided signs.
   1. Furnish inserts, and mechanical and adhesive anchoring devices as specified for the installation of identification signs.

C. Fasteners: Provide fasteners of non-magnetic stainless steel of size and type required and recommended by individual identification sign manufacturers.

D. Anchors and Inserts: Use stainless steel anchors and inserts. Use toothed stainless steel bolts for drilled-in-place anchors.

2.19 FABRICATION

A. Shop Assembly:
   1. Fabricate and preassemble items in the shop to the greatest extent possible.
   2. Disassemble units only to the extent necessary for shipping and handling limitations.
   3. Clearly mark units for reassembly and coordinated installation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and conditions under which the identification signs are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General:
   1. Install identification signs and components at the locations shown on the Drawings or, if not shown, as directed by ENGINEER, securely mounted with concealed very high-bond acrylic foam tape or mechanical/chemical fasteners where specified. Attach signs to surfaces in accordance with the manufacturer's instructions, unless otherwise shown on the Drawings.

2. Mount exit signs in locations shown on the Drawings. Surface mount signs above all exit doors, unless otherwise shown on the Drawings.
3. Lightly mark and locate the position of all identification devices. Obtain ENGINEER'S approval of all locations before mounting. Install level, plumb, and at the proper height. Repair or replace damaged units as directed by ENGINEER.
4. Install very-high-bond acrylic foam tape on back of identification devices using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of identification devices; peel off second release liner and press onto surfaces.
5. Install level, plumb, and at the specified height.
6. The exterior "No Trespassing" signs may need to be mounted on stucco surface or masonry walls with screw fasteners as directed by ENGINEER. Also, signs needing to be attached to wire cyclone fencing shall be as directed by ENGINEER.

B. Room Identification, Directional and Information Signs:
1. Where permanent identification is provided for rooms and spaces, install signs on the wall adjacent to the latch side of the door.
2. Where there is no wall space on the latch side of the door, including at double leaf doors, install signs on the nearest adjacent wall.
3. Mounting height shall be 5 feet-0 inches above the finish floor to the center-line of the sign. Mount such signage so that a person may approach within 3-inches of the sign without encountering protruding objects or, when reading sign, be forced to stand within the swing of a door.

C. Pipe Identification Signs and Tags:
1. The name of the materials in each pipeline and, alongside this, an arrow indicating the direction of flow of fluids, shall be indicated on each pipeline system.
2. Titles shall not be located more than 25 linear feet apart and shall also appear directly adjacent to each side of all walls penetrated by pipeline, adjacent to each side of all valve regulators, flowcheck, strainer cleanouts, and all pieces of equipment. Arrows shall be located at intervals not to exceed 15 linear feet apart.
3. Titles shall identify contents by complete name. Identification title locations shall be determined by ENGINEER, but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering when they are overhead. Title shall be clearly visible from operating positions especially those adjacent to control valves.
4. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures as to prevent damage to the nameplate.

D. Right-To-Know Signs, Labels and Tags:
1. Locate tags at 20 feet maximum center-to-center distance along chemical pipelines and fill pipelines and on each side of all locations where pipes emerge from penetrations with other materials.
2. Install tank signs on all tanks shown to receive signage at quarter-points on tank circumference, 5 foot-0 inches above finished floor.

3.3 PROTECTION AND CLEANING

A. After installation, clean soiled identification device surfaces according to manufacturer's instructions.

B. Protect units from damage until Final Acceptance by OWNER.

+ + END OF SECTION + +

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all toilet and bath accessories Work.
2. Extent of toilet and bath accessories is shown on the Drawings.
3. Types of products required include the following:
   a. Paper towel dispensers.
   b. Paper towels.
   c. Waste receptacles.
   d. Combination paper towel dispenser and waste receptacle.
   e. Toilet tissue dispensers.
   f. Mirrors.
   g. Grab bars.
   h. Soap dispensers.
   k. Miscellaneous fasteners, accessories and trim as required for a complete and functioning installation.

B. Coordination:
1. Furnish inserts and anchoring devices which must be set in concrete or built into masonry and recycled gypsum wallboard for the installation of toilet accessories. Coordinate delivery with other work to avoid delay. Refer to and comply with the requirements of Section 09 29 00, Gypsum Wallboard.
2. Refer to concrete and masonry Sections of these Specifications for installation of inserts and anchorage devices. Refer to and comply with the requirements of 04 20 00, Unit Masonry Construction.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
1. Provide products of the same manufacturer for each type of bath accessory unit and for units exposed in the same areas.
2. Stamped names or labels on exposed faces of units will not be permitted.
3. Provide locks with the same keying for each type of bath accessory units in the Project, wherever possible. Furnish two keys for each lock.

B. Requirements of Regulatory Agencies:
1. Codes: Comply with applicable provisions of the Phoenix Building Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM A 167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel; Steel Plate, Sheet and Strip.

2. ASTM A 366 Specification for Commercial Steel Sheet, Carbon, Cold Rolled.
3. ASTM A 386 Specification for Zinc Coating (Hot-Dip) on Assembled Steel Products.
4. ASTM B 456, Specification for Electro Deposited Coatings of Nickel Plus Chromium.
5. Federal Specification, FS DD-G-451, Glass (Laboratory).
6. Federal Specification, FS WW-P-541.
7. FS WW-P-541, Plumbing Fixtures (Land Use).
8. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical data and installation instructions for each toilet accessory.
   2. Setting Drawings, templates, instructions and directions for installation of anchorage devices in other work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel, ASTM A 167: Type 302/304 with polished No. 4 finish, unless otherwise specified.

B. Brass, FS WW-P-541: Cast or forged quality alloy.

C. Sheet Steel, ASTM A 366: Cold rolled, commercial quality. Surface preparation and metal pretreatment as required for applied finish.

D. Chromium Plating, ASTM B 456: Nickel and chromium electro-deposited on metal, Type SC2.

E. Tempered Mirror Glass, FS DD-G-451: Polished tempered glass, 1/4-inch thick, with silver coating hermetically sealed by electroplating with a copper protective coating. Provide backed mirrors-finished with a non-metallic, waterproof paint coating.

F. Galvanized Steel Mounting Devices, ASTM A 386: Hot-dip galvanized after fabrication.

G. Provide manufacturer's recommended installation accessories for each toilet and bath accessory.

2.2 SURFACE-MOUNTED PAPER TOWEL DISPENSER

A. Size to dispense not less than 400 c-fold towels with interchangeable paper drop. With cabinet and door not less than 22 gauge stainless steel, No. 4 satin finish all welded construction without mitered corners. Hang door with a concealed, full-length stainless steel piano hinge and install a tumbler-lockset.

B. Product and Manufacturer: Provide one of the following:
   1. No. 0210 by American Specialties Incorporated.
   2. B-262 by Bobrick Washroom Equipment, Incorporated.
   3. Or equal.

2.3 SURFACE-MOUNTED WASTE RECEPTACLE

A. Fabricated from not less than 22 gauge stainless steel, No. 4 satin finish all welded construction without mitered corners. Top and bottom hemmed, interior liner hooks, 12 gallon capacity.

B. Product and Manufacturer: Provide one of the following:
   1. No. 0826 by American Specialties Incorporated.
   2. B-275 by Bobrick Washroom Equipment, Incorporated.
   3. Or equal.

2.4 TOILET TISSUE DISPENSERS

A. General: Provide toilet tissue dispensers at each water closet.

B. Multi-roll Toilet Tissue Dispenser and Ash Tray: Fabricate shelf of not less than 18 gauge stainless steel, to store and dispense not less than two 4-1/2-inch by 4-1/2-inch core tissue rolls. Fabricate flange from a single piece, with seamless construction.

C. Product and Manufacturer: Provide one of the following:
   1. No. 0697-GAL by American Specialties Incorporated.
   2. B-2840 by Bobrick Washroom Equipment, Incorporated.
   3. Or equal.

2.5 MIRRORS

A. Accessible Tilt Mirrors:
   1. General: Provide accessible tilt mirror above each accessible lavatory.
   2. Stainless Steel Frame: Fabricate frame from 20 gauge, Type 304L stainless steel, welded and ground smooth, no shelf. Mirrors shall be 18-inches by 36-inches, with tilting frame tapered from 1-1/2-inches at bottom to 4-1/2-inches at top.
   3. Product and Manufacturer: Provide one of the following:
      a. No. 0535-B by American Specialties Incorporated.
      b. B-293 by Bobrick Washroom Equipment, Incorporated.
      c. Or equal.

B. Custom Sized Angle Framed Mirrors:
   1. General: Provide single pane, polished tempered glass mirrors continuous above all non-handicapped lavatories.

2. Stainless Steel Frames: Fabricate frames from 3/4-inch by 3/8-inch 18 gauge, Type 304 stainless steel angle with corners heliarc welded, ground and polished smooth to a uniform satin finish. Provide all mirrors installed on concealed hanging brackets that lock onto top and bottom of frame by tamper-proof set screws.
3. Product and Manufacturer: Provide one of the following:
   a. Custom Sized 0600-B Mirrors by American Specialties, Incorporated.
   b. Custom Sized B-290 Mirrors by Bobrick Washroom Equipment, Incorporated.
   c. Or equal.

2.6 SURFACE-MOUNTED HORIZONTAL LIQUID SOAP DISPENSER/SHELVES

A. General: Provide surface-mounted liquid soap dispensers, one per lavatory; 20-inches long by 2-1/2-inches high by 4-5/10-inches wide, with one liquid soap dispensing valve.

B. Liquid Soap Dispenser: Fabricate units from 20 gauge stainless steel, with pin-type tumbler locking device. Provide 20 gauge stainless steel shelf using one-piece construction, with integral sides. Dispense liquid soap in measured quantity by pump action with stainless steel internal springs, ABS piston, stainless steel push button and internal parts. Cabinet shall have no exposed fastening devices.
   1. Capacity: 80 fluid ounces.
   2. Locking: Pin-type tumbler lock with ten extra keys.

C. Product and Manufacturer: Provide one of the following:
   1. No. 0315 by American Specialties, Incorporated.
   2. B-2014 by Bobrick Washroom Equipment, Incorporated.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which toilet accessories are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install items required to meet accessibility codes in accordance with the Phoenix Building Code.

B. Use concealed fastenings wherever possible.

C. Provide anchors bolts, fasteners and other necessary anchorages, and attach accessories securely to walls, floors and partitions in locations as shown on the Drawings.

D. Install concealed mounting devices and fasteners fabricated of the same material as the accessories as recommended by manufacturer.

E. Install exposed mounting devices and fasteners finished to match the accessories.

F. Provide theft-resistant fasteners for all accessory mountings.

G. Secure and install toilet room accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

H. Lock grab bars to concealed mounting plate installed in wall.

3.3 ADJUSTMENT AND CLEANING

A. Adjust accessories for proper operation.

B. After completion of installation, clean and polish all exposed surfaces.

C. Deliver keys and instruction sheets to OWNER.

+ + END OF SECTION + +

SECTION 10 44 16.13

PORTABLE FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all portable fire protection equipment Work.
   2. The extent of the portable fire protection equipment Work shall be as shown on the Drawings.
   3. The types of portable fire protection equipment Work required includes, but is not necessarily limited to, the following:
      a. Dry chemical extinguishers.
      b. Carbon dioxide extinguishers.
      c. Mounting accessories and miscellaneous fasteners.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the portable fire extinguishers.
   2. Refer to and comply with the requirements of Section 10 14 00, Identification Signs.

1.2 QUALITY ASSURANCE

A. Source Quality Control: Provide portable fire protection equipment Work from only one manufacturer.

B. Requirements of Regulatory Agencies: Provide only portable fire extinguishers that are approved and labeled by UL.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. UL, Fire Classification Rating.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical data, certification of UL rating, and installation instructions for all portable fire protection equipment Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide manufacturer's standard mounting brackets for portable fire extinguishers size as specified.

B. Multi-Purpose Dry Chemical:
   1. 10-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.
   2. Product and Manufacturer: Provide one of the following:
      a. Cosmic Model 10E by J.L. Industries.
      b. Model 10 TAS by Walter Kidde and Company.
      c. Or equal.

C. Carbon Dioxide:
   1. 10-pound enameled steel container capacity, for Class B and Class C fires UL rating.
   2. Product and Manufacturer: Provide one of the following:
      a. Sentinel Model 10 by J.L. Industries.
      b. 10 KS-3 by Walter Kidde and Company.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and conditions under which the portable fire extinguishers are to be installed, and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install in locations and at mounting of 3 feet-0 inches. Securely fasten to structure, square and plumb, in accordance with manufacturer's instructions.

B. Wherever exact locations of units are not shown on the Drawings, locate as directed by ENGINEER.

C. Install signs directly above surface mounted portable fire extinguishers, securely mounted, attached to substrate in accordance with manufacturer's instructions. Install level and plumb.

D. Recharge and bring last inspection date up to coincide as nearly as possible with date of Final Acceptance by OWNER, to provide full term inspection interval.

E. Inform OWNER of next required inspection and recharging date.

3.3 SCHEDULE

A. Type A - Dry chemical, wall mounted.

B. Type B - Carbon dioxide, wall mounted.

+ + END OF SECTION + +

SECTION 11 00 00

GENERAL EQUIPMENT PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. These General Equipment Provisions apply, to all equipment furnished under this Contract including equipment specified in Division 11, Equipment, Division 13, Special Construction, Division 14, Conveying Equipment, Division 15, Mechanical, Division 26, Electrical, and Division 40, Process Interconnections. These General Provisions shall supplement the Detailed Equipment Specifications, but in case of conflict the Detailed Equipment Specifications shall govern.

B. Environmental Conditions:
   1. All equipment and appurtenances specified in the scope of this Section shall be designed and configured for installation and operation in a corrosive environment.
   2. Equipment shown or specified for exterior locations shall be designed for continuous operation in a dusty environment, with normal ambient air temperatures of 120°F, and exposed to air that contains corrosive compounds.

1.2 QUALITY ASSURANCE

A. Arrangement:
   1. The arrangement of equipment shown on the Drawings is based upon information available to the ENGINEER at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require coordination to meet actual equipment installation requirements. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be coordinated to accommodate the equipment provided. No additional payment will be made for the coordination.

B. Unit Responsibility:
   1. Equipment systems made up of two or more components shall be manufactured and assembled as a unit by the responsible manufacturer. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components, such that all equipment furnished under the specification for the equipment system, including equipment specified elsewhere, but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. Agents, representatives or other entities that are not a direct component of the

manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in conforming to this requirement. This requirement for unit responsibility shall in no way relive CONTRACTOR of his responsibility to the OWNER for performance of all systems.

2. Assure that all equipment systems provided for the Project are products for which unit responsibility has been accepted by the responsible manufacturer. Where the detailed specification requires a certificate from the Unit Responsibility Manufacturer, coordinate delivery of such certificates. Certificates shall conform to the content, form and style of Form 01600-B specified in Section 01 33 10, Reference Forms, Reference Forms, shall be signed by an officer of the manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the Work.

1.3 WORKMANSHIP AND MATERIALS

A. All equipment shall be designed, fabricated and assembled in accordance with the best modern engineering and shop practice and in accordance with applicable standards. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required for tests.

B. In various Sections of the Specification, manufacturer's names have been used for clarity and to establish minimum product standards only. Responsibility for selection and coordination of all materials required for construction belongs to CONTRACTOR.

C. All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty and under the specified and indicated operating conditions. Any part of mechanical equipment that shows excessive wear or fails due to wear, under normal operating conditions, within the warranty period shall be considered as evidence of defective material or defective workmanship, and it shall be replaced by CONTRACTOR with equipment or parts to meet the specified requirements, at no additional cost to the OWNER.

D. Bronze which shall be in contact with water or any liquid, used in the manufacture of any equipment shall not contain aluminum or more than six percent zinc, and shall conform to ASTM B62, or equivalent.

E. Tolerances and clearances, shall be as indicated on the Shop Drawings, and these tolerances and clearances shall be closely followed to secure proper operation of the equipment.

F. All flanges on equipment and equipment appurtenances furnished shall conform in dimensions and drilling to ANSI B16.1, Class 150, unless otherwise noted.

G. Responsibility to coordinate compatible materials of construction for all elastomer components for all seats, seals, gaskets, etc., for each process application belongs to CONTRACTOR.

1.4 MANUFACTURER'S NAMES

A. Manufacturer's name and catalog numbers are for the convenience of CONTRACTOR. The detailed Contract Documents shall apply in the event of a conflict. If detailed Contract Documents have not been given, the manufacturer's name and catalog number shall determine the design criteria for comparison should an equal be submitted.

1.5 REGULATIONS AND CODES

A. Electrical and Instrumentation Work, furnished with equipment supplied under Division 11, Equipment, Division 13, Special Construction, Division 14, Conveying Systems, and Division 15, Mechanical, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the requirements of Division 16, Electrical, and Division 17, Instrumentation. When applicable, the material used in the performance of the electrical Work shall be approved by the Underwriter's Laboratories, Inc. (UL) for the class of service for which they are intended.

1.6 BEARINGS

A. Unless otherwise specified, all equipment bearings shall be oil or grease lubricated and ball or roller antifriction type of standard manufacture. Bearings shall be conservatively designed to withstand all stresses of the service specified. Each bearing, except as otherwise noted, shall be rated in accordance with the latest revisions of Anti-Friction Bearing Manufacturer's Association's (AFBMA) Methods of Evaluating Load Ratings of Ball and Roller Bearings for B-10 rating life of 100,000 hours.

B. All grease lubricated bearings, except those specified to be factory sealed lubricated, shall be fitted with easily accessible grease supply, flush, drain, and relief fittings of the standard hydraulic type. Extension tubes shall be provided for easy access.

C. Oil-lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 55□C and shall be equipped with a filler pipe and an external level gauge. Fittings for pressure lubrication shall be 1/4-inch straight type.

D. To avoid work hardening or "Brinelling" damage from vibration, bearings shall be separately packed or otherwise suitably protected during transport.

E. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with

Arizona Administrative Code R18-04-119, Standards for Additives, Materials, and Equipment.

1.7 LUBRICATION AND LUBRICATION FITTINGS

A. Equipment shall be adequately lubricated by systems that require attention no more often than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity for consumption prior to completion of required testing and commissioning of equipment. Provide the ENGINEER at Substantial Completion of the Project or portion of the Project, electronic PDF list showing the proper lubricants for each item of mechanical equipment, approximate quantities needed per year of continuous operation, and recommended lubrication intervals. Wherever possible, the types of lubricants shall be consolidated with the manufacturer's approval to minimize the number of different lubricants required for plant maintenance.

B. Equipment and bearing lubrication fittings shall be extended with piping beyond obstructions, such as guards or covers, to provide ease of lubrication without disassembly of the unit.

C. All lubrication fittings shall be constructed of Type 304L stainless steel and shall be brought to the outside of all equipment so they are readily accessible from the outside without the necessity of removing covers, plates, housing, or guards. Fittings shall be of button head type. Lubrication fittings shall be mounted together wherever possible and shall be made of factory-mounted multiple fitting assemblies. Fittings shall not be individual fittings field-mounted together.

D. Lubrication: Food grade oil meeting NSF 61 for water applications.

1.8 EQUIPMENT BASES AND BEDPLATES

A. A heavy cast iron, FRP, or stainless steel base shall be provided for each item of equipment that is to be installed on a concrete base, in accordance with the equipment manufacturer's requirements. Equipment assemblies, unless otherwise specified or shown on the Drawings, shall be mounted on a single, heavy, cast iron, FRP, or stainless steel bedplate, in accordance with the equipment manufacturer's requirements. Bases and bedplates shall be provided with machined support pads, tapered dowels for alignment of mating or adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. Seams and contact edges between stainless steel plates and shapes shall be continuously welded and ground smooth. Bedplate drain fittings shall be piped to the nearest sump or designated drainage area.

B. After assembly and installation on the concrete base, each unit shall be leveled, using a precision level, and aligned in place but not grouted until after the initial fitting and alignment of connecting piping. Each unit shall then be grouted to the concrete base. Each base and bedplate shall be completely filled with grout, where applicable. The grout shall extend to the edge of each base or bedplate and shall be beveled at 45 degrees all around the unit. Grout exposed at horizontal surfaces

shall be rounded to provide drainage to appropriate points. After grout has set, jacking screws shall be removed, and nuts on anchor bolts shall be tightened followed by an overall check on leveling and alignment. Should equipment not meet tolerances of leveling and alignment, as recommended by the manufacturer, corrective measures shall be taken to obtain the tolerances required. Reciprocating equipment shall be grouted with non-shrinking epoxy grout, as specified under Section 03 60 00, Grouting.

1.9 EQUIPMENT GUARDS

A. Belt or chain drives, fan blades, couplings, exposed shafts, and other moving or rotating parts shall be covered on all sides by guards conforming with the General Industry Safety Orders of the Arizona Division of Industrial Safety. The guards shall be fabricated from 15 USS gauge or heavier aluminum or Type 316 stainless steel. Each guard shall be designed for easy installation and removal. Necessary supports and accessories shall be provided for each guard. Guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water. Drawings of the guards shall be submitted to the ENGINEER for approval prior to fabrication or delivery.

B. Secure guards in position by aluminum or Type 316 stainless steel braces or straps, securely fastened to floor, wall, or frame of the equipment. Fastenings shall permit easy removal for servicing the equipment.

1.10 EQUIPMENT DATA NAMEPLATES

A. Manufacturers nameplates shall meet requirements as stated in individual equipment specifications. Manufacturers equipment data nameplates shall be stamped on Type 316 stainless steel and fastened to the equipment in an accessible location with No. 4 or larger oval head Type 316 stainless steel screws or drive pins. The nameplate shall include manufacturer’s name, equipment model number, serial number, drive speed, motor horsepower, and rated capacity etc. Manufacturers nameplates for pumps shall also include, at a minimum, rated total dynamic head, impeller size and capacity, where applicable.

B. All storage tanks (steel, fiberglass and polyethylene), shall include a second sign with the description of the contents. The lettering on the sign shall be visible from at least ten feet.

C. Refer to Section 01 93 13.15 for CMMS Tag requirements.

1.11 WARNING SIGNS

A. Furnish and install permanent warning signs at all mechanical equipment, prior to startup, that may be started automatically or from remote locations. Signs shall be located near the equipment, in accordance with safety regulations, and shall be suitable for exterior use.

B. Warning signs shall be colored yellow with black letters, on not less than 18 gauge vitreous enameling stock. Copy shall read:

CAUTION:
THIS EQUIPMENT STARTS
AUTOMATICALLY

C. Each sign shall be clearly readable from a distance of 20 feet.

D. Additional warning sign requirements are specified in Section 10 14 00, Identification Signs.

1.12 EQUIPMENT PAINTING/COATINGS

A. Surfaces requiring painting or coating for corrosion protection shall be smooth, free from sharp edges, burrs, and projections and shall have all welds ground smooth and all edges and corners of structural members rounded. Non-conformance shall be grounds for rejection of equipment, as determined by the ENGINEER.

B. Equipment shall be shop-primed prior to delivery to the Work site, unless otherwise specified, in accordance with Section 09 90 00, Painting and Coating.

C. Surfaces of equipment, which will be inaccessible after assembly, shall be painted or otherwise protected before assembly by a method that provides protection for the life of the equipment. Furnish equipment to replace any equipment that the ENGINEER determines to be damaged beyond repair by rust or mishandling, etc., while in storage or during installation by CONTRACTOR.

D. Manufacturers equipment or motor data nameplates shall not be painted.

E. The equipment supplier shall certify, by a letter included with the equipment submittal, confirming that the proposed primer and finish coating used is compatible with the approved Division 9, Finishes, painting scheme. After delivery to the Work site, the equipment finished surfaces shall be inspected and evaluated. A final coat of paint shall be applied to all equipment in the field .

F. Machined, polished, and other ferrous and non-ferrous surfaces that are not to be painted shall be coated with rust preventative compound, Dearborn Chemical “NO-Ox-Id”, Houghton “Rust Veto 344,” Rust-oleum “R9,” or approved equal. Should rust occur during shipment or storage, responsibility for correction, as determined by the ENGINEER, belongs to CONTRACTOR.

G. Copper, bronze, chromium plate, nickel, stainless steel, aluminum, monel metal, lead, lead coated copper, brass, and plastic are not to be painted or finished, unless otherwise specified or recommended by the manufacturer.

H. All metallic surfaces requiring a shop applied primer shall be primed with an approved priming system that has been certified, by letter, as being compatible with the Division 9, Finishes, coating systems proposed and shall be applied in

accordance with the recommendations of the paint manufacturer. Submittal for equipment shall include:

1. Coating manufacturer's "Cut-sheet" describing components, surface preparation requirements, recommended mil thicknesses, and application procedures for the proposed primer.
2. A letter from the equipment supplier stating that he has confirmed that the proposed primers are compatible and that the primer will be applied in accordance with the coating manufacturer's requirements. In addition, the letter shall certify that the appropriate surface preparations will be made prior to primer application.

I. After delivery to the Work site, equipment surfaces shall be inspected and evaluated by the ENGINEER. Touch-up or complete removal of shop priming, by sandblasting or other approved method, may be required as determined by the ENGINEER based on the condition of the equipment primer prior to final, in place, finish coat application.

J. Field touch-up, final surface preparation, and final finish coatings shall be applied by CONTRACTOR.

1.13 FACTORY TEST AND CERTIFICATION

A. All equipment, devices, and systems requiring factory test and certification, as specified in these Specifications, may be witnessed by the OWNER. Notify the ENGINEER, in writing, at least 30 calendar days in advance of all equipment, devices and system testing. The written notifications shall specify the exact date and location of the tests that will be conducted and shall define the test procedures to be utilized. Testing procedure shall be scheduled and performed during normal working hours and shall be subject to review by the ENGINEER.

1.14 VARIABLE FREQUENCY DRIVES

A. Variable frequency drives, motors, and pumps furnished by OWNER shall be installed by CONTRACTOR and tested in accordance with Paragraph 1.14.C., below.

B. Unit Responsibility:

1. Have unit responsibility for proper coordination and compatibility of all Variable Frequency Drives (VFDs) and controls furnished under Division 16, Electrical, with the Division 11, Equipment, equipment and motors specified in the Contract Documents, and shall have total responsibility for the satisfactory installation and operation of the entire driven system, including driven equipment, motors, drives, and controls as specified in the Contract Documents.
2. The Division 11, Equipment, manufacturer shall assume sole unit responsibility for the equipment and motors, and shall assume responsibility that the motors supplied with the equipment will successfully operate the equipment over the specified operating speed range. The equipment package, including motors, shall operate successfully over the speed range and all other operating characteristics provided by VFDs.

3. The motor manufacturer shall submit written approval, in letter form, of the VFD to be furnished as part of the submittal package. The equipment manufacturer shall perform field testing necessary to confirm compatibility of the drives with successful operation of the equipment throughout the complete operating range specified.
4. The Division 11, Equipment, manufacturer shall review the location of and relationship of the VFD with respect to the driven equipment and motor, and certify, in writing, the relationship will satisfactorily operate the unit(s) for its intended normal operating lifetime.

C. Testing:
1. Field Acceptance Testing: After installation of the system at the Work site and checkout by the drive manufacturer, a field acceptance test shall be conducted jointly by the drive manufacturer and the manufacturer of the driven equipment.
   a. The field acceptance test shall consist of repeating the factory acceptance testing procedure and an additional 24 hours of similar testing, during which the system shall run continuously without loss of basic functions. Functional tests shall demonstrate satisfactory operation of all interlocks, alarms, and normal operating sequences. The drive manufacturer shall use suitable test equipment to identify and correct malfunctions. Failure of redundant equipment will not be considered as downtime, provided that automatic failover occurs as specified herein and, that in the opinion of the ENGINEER, the failure was not caused by deficiency in design or installation. Repeated failure of any component shall be cause for the acceptance test to be terminated and restarted.
   2. Verify that harmonics comply with the requirements of IEEE-519 at the motor control center.

1.15 EQUIPMENT INFORMATION FORMS

A. Complete Form 01600-A found in Section 01 33 10, Reference Form, for all equipment and devices that are specified in the Contract Documents. This includes each component mounted as a package, or “skid” mounted equipment and control panels. The completed Equipment Information Forms shall be included in the individual Operation and Maintenance Manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 22 00 11

INSTALLATION OF PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all plumbing piping to the limits shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Phoenix Plumbing Code.
   2. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ANSI B13.1, Code for Pressure Piping.
   2. ANSI B31.1, Power Piping.
   3. AWS D10.9, Standard for Qualifications of Welding Procedures and Welders for Piping and Tubing.
   4. NSF/ANSI 61, Drinking Water System Components Health Effects.
   5. Arizona Administrative Code R18-4-119, Standards for Additive, Materials, and Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed 1/4-inch scale drawings showing dimensions and materials of piping system. Refer to applicable piping systems in other Sections under this Contract for additional required submittals.
   2. Certificate of Compliance with NSF/ANSI 61 standard or with Arizona Administrative Code R18-4-119, in accordance with Section 11 00 00 requirements.

B. Record Drawings: During progress of the Work, keep an up-to-date set of drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit mylar drawings showing the actual in-place installation of all piping and equipment installed under this Section, at a scale satisfactory to OWNER. The drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete "Record Drawings" of the piping systems. Two paper prints shall also be furnished. The mylar drawings

shall be furnished not later than 30 days after Final Completion of the Work and prior to final payment.

1.4 JOB CONDITIONS

A. Sequencing: Obtain approval of Shop Drawings and layout drawings before placing concrete and installing any piping.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials for piping system shall be specified under applicable Sections of Division 15, Mechanical.
B. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION

3.1 BEFORE INSTALLATION

A. General: Thoroughly plan the installation of piping systems prior to placing concrete so that inserts, openings, sleeves, supports and blocking will be correctly located.

B. Defective Materials: Examine piping, fittings, valves, and accessories to be installed and reject those which are defective or in poor condition.

C. Cleaning: Thoroughly clean all piping, fittings, valves and accessories.

3.2 INSTALLATION

A. General:
   1. Install all items as shown on the Drawings, specified, and as recommended by the manufacturer.
   2. Request instructions from ENGINEER when there is a conflict between the manufacturer's recommendations and the Contract Documents.
   3. Present conflicts between piping systems and equipment or structures to ENGINEER who will determine corrective measures to be taken.
   4. Do not modify structures to facilitate installation of piping, unless specifically approved by ENGINEER.
   5. Wherever plumbing piping crosses a building expansion joint, provide a suitably sized expansion joint or expansion loop with guides located as recommended by the manufacturer.

B. Piping:
   1. Install straight runs true to line and elevation.

2. Install vertical piping tight to walls, columns and truly plumb leaving clearance for vertical supports only.
3. Install piping parallel or perpendicular to building walls. Piping at odd angles and 45 degrees runs across corners will not be accepted, unless specifically shown on the Drawings.
4. Install small diameter piping generally as shown on the Drawings when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, etc.
5. Unless otherwise approved by ENGINEER, provide temporary caps or plugs over all pipe openings at the end of each day's Work, or when otherwise required or directed, to prevent foreign material from entering the piping systems.
6. Cutting: Cut pipe from measurements taken at site, not from the Drawings.

C. Joints:
1. General:
   a. Make joints in accordance with the pipe manufacturer's recommendations and the supplemental specifications below.
   b. Cut piping accurately and squarely and install without forcing or springing.
   c. Ream out all pipes and tubing to full inside diameter after cutting.
   d. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
2. Threaded Joints: Use standard, right hand tapered full depth threads on steel piping and apply an approved joint compound to the male threads only, before installation. Leave not more than three pipe threads exposed at each connection.
3. Solder Joints:
   a. Ream or file pipe to remove burrs.
   b. Clean and polish contact surfaces of joints.
   c. Apply flux to both male and female ends.
   d. Insert end of tube into fittings full depth of socket.
   e. Heat joint evenly.
   f. Form continuous solder bead around entire circumference of joint.
4. Flanged Joints: Assemble flanged joints with approved full-face gaskets and gasket compounds and draw up flange bolts evenly.
5. Plastic Pipe Joints: Make joints in plastic piping in accordance with the manufacturer's recommendations.
6. Welded Joints: ANSI B31.1 latest revision and requirements of the American Welding Society for pipe welding.
7. No-Hub Coupling Joints:
   a. Clean the external surface of the ends of the pipe and fittings to be joined so they are free from dirt, mud, gravel or other foreign matter.
   b. Place the gasket on the end of one pipe and the stainless steel clamp assembly on the end of the other pipe or fitting.
   c. Firmly seat the pipe or fitting ends against the integrally molded shoulder inside the rubber gasket.
   d. Slide the clamp assembly into position over the gasket and tighten the bands as described below.
   e. Torquing the Bands: Use a properly calibrated torque wrench, set at the torque recommended by the coupling manufacturer.
8. Compression Joint Installation:

a. Clean the internal surface of the hub and external surface of the spigot end of the pipe and fitting so they are free from dirt, mud, gravel, or other foreign material.
b. When using cut pipe, the sharp edge must be removed. This can be accomplished by peening or filing the edge. This will prevent cutting or scraping of the gasket.
c. Insert the gasket into the hub, making sure the retaining flange or collar of the gasket is adjacent to the face of the hub.
d. Lubricate as follows: Use a thin coat applied only on the inside of the gasket, unless the pipe manufacturer also recommends lubricating the spigot of the pipe or fitting.
e. Align the spigot or hub to be joined, keeping the spigot and hub in a straight line.
f. By the use of any of the tools available, force the spigot end of the pipe or fitting into the gasket. All tools should be used according to the manufacturer's recommendations.
g. Gaskets should be stored in a clean, dry area in an un-deformed condition away from excessive heat.
h. All changes of direction shall be restrained.

D. Unions:
1. Install dielectric unions wherever dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions where shown on the Drawings and to provide for ready dismantling of piping.

E. Eccentric Reducers: Use eccentric reducers where shown on the Drawings and where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

F. Valves and Accessories:
1. Provide supports for large valves, flow meters and other heavy items as shown on the Drawings or otherwise required.
2. Install floor stands as shown on the Drawings and as recommended by the manufacturer.
3. Provide lateral restraints for extension bonnets and extension stems as shown on the Drawings and as recommended by the manufacturer.

G. Drip Pans:
1. Install 24 gauge galvanized steel drip pans below any plumbing piping passing over any electrical panel or motor control center.
2. Plumbing piping shall NOT be installed over switchgear regardless of circumstances, unless piping is embedded in concrete.
3. Drip pans shall be 12-inches wider than the pipe it serves with an 1-1/2-inch high lip all around. Pan shall be sloped to a 1-inch drain connection. Drain connection shall be piped to a wall then down to 6-inches above the floor.

3.3 AFTER INSTALLATION

A. Remove and replace any items which are found to be defective after installation.

B. Repair damaged mortar pipe lining as recommended by the manufacturer and approved by ENGINEER.

C. Clean all debris out of piping systems.

D. Replace all "start-up" strainer screens and install "operational" strainer screens, where applicable.

E. Maintain all piping, fittings, valves and accessories in clean undamaged condition until Final Completion.

+ + END OF SECTION + +

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SECTION 22 00 12

TESTING OF PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all tests necessary to demonstrate compliance with the Contract Documents, codes and regulations, which include water tests, air tests, and smoke tests as specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, and exposed piping installation.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Phoenix Building Code.
      b. Phoenix Plumbing Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Description of proposed testing methods, procedures, and apparatus to the ENGINEER for approval at least 48 hours in advance of testing.
   2. Submit a test report for each test to the ENGINEER certifying the test pressure, duration of the test, and test performance of all installed piping.
   3. Valve Charts:
      a. Two required, 1/8-inch sheet acrylic in 8-1/2 by 11-inch extruded aluminum frame.
      b. Charts: Typed or inked on mylar with the following information for each valve.
         1) Valve identification number.
         2) Valve location.
         3) Valve use.
         4) Valve size.
         5) Manufacturer's name and model number.
      c. Submit sample valve chart with lettering.

   4. Certificate of Compliance with NSF/ANSI 61 standard or with Arizona Administrative Code R18-4-119, in accordance with Section 11 00 00 requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all necessary equipment and materials, including gages and pumps, to perform the testing operations.

B. All materials or products which can contact drinking water as part of a water treatment process or water supply system, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

2.2 CMMS TAGS

A. Refer to Section 01 93 13.15, Computerized Maintenance Management System Tags for guidance.

B. Legend:
   1. P.W. - Potable Water.

PART 3 - EXECUTION

3.1 GENERAL

A. Conduct water, air and smoke tests as required on all piping systems, as specified below and conforming to the requirements of Section 33 14 10, Piping Systems.

B. Conduct all tests in the presence of and in a manner approved by ENGINEER and the OWNER. Repeat test for the OWNER and ENGINEER, if requested.

C. Repair and retest all lines which do not pass the tests as specified herein.

D. Inspect all valves, joints, and specialties for tightness and for proper operation while under test pressure.

3.2 WATER TEST

A. Drainage and Vent System Piping:
   1. Perform tests either on the entire system or on successive sections of the system.
   2. Tightly close all openings, except the highest opening, of the system or section to be tested.
   3. Fill the system or section with water to the point of overflow.
   4. Test with a head of at least ten feet of water, except for the uppermost ten feet of the system.
   5. Allow water to stand in the system for at least 15 minutes before inspecting.
   6. Inspect the system or section for leaks and repair any leaks found.

B. Water Piping:

1. Water piping shall be tested and proved tight under a pressure not less than 100 psi.
2. Potable water shall be used for testing potable water systems.

3.3 AIR TEST

A. Attach air compressor testing apparatus to any suitable opening after closing all other inlets and outlets. Force dehydrated, oil-less, compressed, dew point - 40°F, air into system until there is a uniform gage pressure without the introduction of additional air. Below is a list of required gage pressures:
   1. Drainage and Vent Piping (substitute for water test) five psi for 15 minutes.
   2. Compressed Air Piping:
      a. Compressed air shall be tested at 150 psig for one hour. Duration time period to be measured after stabilization of the testing medium.
      b. All joints, fittings valves and other potential leak sources shall be swabbed with a leak detecting solution.
      c. A calibrated pressure gauge having maximum increments of two psi shall be used.
      d. Only temporary weld-end dished-head caps or threaded-end caps, swell plugs or compression end caps (maximum 2-inch) shall be installed during pressure test operations.
      e. No compression couplings larger than 2-inches shall be included in the pressure test inside buildings unless they are adequately blocked or anchored to prevent pull-out from thrust forces. All piping shall be securely anchored or blocked to prevent movement or blowouts.
      f. Do not include meter, regulator and final service tee at main in leakage test. This equipment shall be leak tested at service line pressure.

3.4 SMOKE TEST

A. Finished Plumbing: Final test for gas and water tightness of the completed drainage and vent system:
   1. Fill all traps with water.
   2. Introduce a pungent thick smoke, produced by one or more smoke machines, into the system.
   3. When the smoke appears at stack openings on the roof, close the system.
   4. Maintain a pressure in the system equivalent to a 1-inch water column for the period of the inspection.
   5. Inspect the system for leaks and repair any leaks found.

+ + END OF SECTION + +

SECTION 22 01 10.52

DISINFECTION, PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Responsibility belongs to CONTRACTOR for the proper disinfection of all potable water lines with compliance to codes and regulations, as specified.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Phoenix Building Code.
      b. Phoenix Plumbing Code.
   2. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of following, except as otherwise shown or specified:
   1. AWWA C651 - Standard for Disinfecting Water Mains.

C. Testing: Bacteriological tests, as specified below, will be provided by the OWNER.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Description of the forms of chlorine, dosages and proposed methods of application.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all necessary equipment and materials, including chemicals, to perform the disinfecting operations.

+ + END OF SECTION + +

SECTION 22 05 17

WALL PIPES, FLOOR PIPES AND PIPE SLEEVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces, and escutcheons to complete the Work.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.4, Cast-Iron Threaded Fittings.
   3. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
   4. AWWA C106 (ANSI A21.6), Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water and Other Liquids.
   5. AWWA C110 (ANSI A21.10), Ductile Iron and Gray Iron Fittings, 3-in. Through 48-in., for Water and Other Liquids.
   6. AWWA C111 (ANSI A21.11), Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
   7. AWWA C115 (ANSI A21.15), Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges.
   8. AWWA C151 (ANSI A21.51), Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   9. AWWA C200, Steel Water Pipe 6-Inches and Larger.
   10. Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wall and Floor Pipes:
   1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER.
   2. Length: Wall fittings shall be equal to the thickness of the wall in which they are installed plus the exterior projection required for connection.
   3. End Connections: As shown on the Drawings or approved by the ENGINEER.
   4. Thickness: Same as specified for the piping connected to wall or floor pipe, except for stainless steel piping.
   5. Collars: Provide collars at mid-point of wall for anchorage and water tightness.
   6. Pipes ends shall be flush with wall face, unless otherwise shown on the Drawings.
   7. Flanged ends and mechanical joint bells shall be drilled and tapped for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.
   8. Steel pipe which is cast into walls or floors shall have a collar at mid-point of wall for anchorage and water tightness, as shown on the Drawings or as required.

B. Pipe Sleeves:
   1. Ferrous and Plastic Pipe: Use standard weight steel pipe with integral wall collar continuously welded to mid-point of sleeve for anchorage and water tightness, unless otherwise shown on the Drawings.
   2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown on the Drawings.
   3. Size sleeves to provide annular space required to accommodate mechanical link-type seals that are used.

C. Cast Wall Sleeves:
   1. Material: Ductile iron furnished with integral wall collar.
   2. Dimensions: As required for pipe to pass through sleeve. Length as required.

D. Mechanical Seals: Provide link-type mechanical seals in pipe sleeves with adjusting bolts suitable for 20 psi working pressure.
   1. Type: Mechanical seals through non-fire rated walls or floors:
      a. Pressure Plate: Glass reinforced nylon plastic.
      b. Bolts and Nuts: 18-8 stainless steel.
      c. Sealing Element: EPDM rubber.
   2. Type: Mechanical seals through buried steel sleeves:
      a. Pressure Plate: Composite.
      b. Bolts and Nuts: Type 316 Stainless Steel.
      c. Sealing Element: EPDM rubber.
   4. Product and Manufacturer: Provide one of the following:
      a. Thunderline Corporation.
      b. Or equal.

E. Wall and Ceiling Plates:
   1. Bare pipes passing through walls and ceilings in finished rooms: Provide escutcheon plates of chrome plated steel, clevis or split ring and hinged with set screws.

2. Insulated pipes passing through walls, floors, and ceilings in finished rooms: Provide plated escutcheon plates of 18 gage chrome plated steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall and Floor Pipes: Install as shown on the Drawings and in accordance with approved Shop Drawings and manufacturer's recommendations.

B. Pipe Sleeves:
1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown on the Drawings.
2. All sleeves through floor slabs in process areas shall extend a minimum of 2-inches above finished floor.
3. All sleeves through floor slabs in finished areas shall extend a maximum of 1/4-inch above finished floor.
4. Anchor sleeves to concrete and masonry walls as shown on the Drawings or otherwise approved by the ENGINEER.
5. Sleeves through walls shall be flush with wall face.
6. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
7. For mechanical seals size sleeves to provide annular space required to suit link-type mechanical seals that are provided.
8. Do not install sleeves and pipes through structural members, unless specifically shown on the Drawings and approved by the ENGINEER. Such sleeves, if required, shall be Schedule 40, steel pipe or approved seamless steel tubing.
9. Size sleeves to provide annular space as follows:

Pipe Size	Sleeve ID Minus Pipe or Insulation OD
Less than 2-inches	1/2-inch to 3/4-inch
2-inches to 4-inches	3/4 inches to 1-1/4-inch
6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

10. Seal annular spaces between pipe and sleeve, material and installation shall be as specified in Section 07 92 00, Calking and Sealants.
11. Buried pipe sleeves shall have mechanical seals at each end.

C. Install wall and ceiling plates in accordance with the manufacturer's recommendations and the approved Shop Drawings.

+ + END OF SECTION + +

SECTION 22 05 29

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to design, furnish, and install all hangers, supports and appurtenances required to complete the Work.

1.2 QUALITY ASSURANCE

A. Each type of pipe hanger, pipe guide, anchor or support shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. The Manufacturers Standardization Society of the Valve and Fittings Industry:
      a. MSS SP-58, Pipe Hangers and Supports - Materials and Design.
      b. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
   2. Federal Specification, FS A-A-1192, Hangers and Support, Pipe.
   3. ASTM A 575, Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   4. Underwriters' Laboratories, Inc., Standard UL-203-Pipe Hanger Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings showing all hangers, supports and expansion compensation for each piping system specified. Shop Drawings shall show location, installation, material, loads and forces, and deflection of all hangers and supports, including expansion and contraction. Each pipe system shall be analyzed for all loads and forces on the hangers and supports, and their reaction forces to the structure to which they are fastened.
   2. Submit and coordinate these with Shop Drawings required for all piping systems, valves and appurtenances.
   3. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

B. Product Information: Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP-58, MSS SP-69 and Federal Specification A-A-1192.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver pipe hanger inserts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all materials off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:
1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
3. Install hangers or supports at all locations where pipe changes direction.
4. All hangers and supports shall be capable of adjustment after placement of piping.
5. Different types of hangers or supports shall be kept to a minimum.
6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
9. Maximum support spacing, unless otherwise shown on the Drawings or approved shall be as follows:

Pipe Size (inches)	Maximum Pipe Span [1] (feet)			
	Steel	Copper	Plastic [2]	Cast/Ductile Iron [4]
3/8 to 3/4	5	6	Cont. [3]	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-
3	10	10	5	-
4	12	12	5	12 feet for

6	12	12	5	pressure pipe
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	
16	12	-	-	
18	12	-	-	
20	12	-	-	
24	12	-	-	10 feet for soil pipe

[1] Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

[2] Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

[3] Continuous means pipe shall be in unistrut or similar channel.

[4] Pipe hanger and support selection shall be as shown on the Drawings and this Section.

10. Maximum support spacing, unless otherwise shown on the Drawings, for plastic pipe at ambient temperature shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130°F shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended therefrom.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.
17. Pipe stands shall be a minimum of 3-inches in diameter and the discharge header shall have hold-down straps. Supports shall have a minimum of 2-inch dry packed grout under 100 percent of the support plate and no voids are allowed. The grout shall be struck off tapered on all sides.
18. Wherever there is a removable, serviceable piece of equipment within the piping system, there must be a support on either side in such a way to allow the equipment to be removed without disturbing the pipe alignment.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
   1. $\Delta L = L \times \Delta T \times \alpha$

a. Where ΔL = pipe length change (in.)
b. L = pipe length between anchors (in.)
c. ΔT = 100 (F)
d. α = coefficient of thermal expansion (in./in./F)

2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
3. Expansion compensation shall be achieved via expansion joints specified in Section 22 05 17, Wall Pipes, Floor Pipes and Pipe Sleeves.

2.2 HANGERS AND SUPPORTS

A. Hangers, supports, pipe guides and anchors where shown shall be in accordance with the Drawings. Hangers and supports not shown shall be in accordance with MSS SP-58.

B. Product and Manufacturers: Provide one of the following:

1. ITT Grinnell Company.
2. Elcan.
3. B-Line.
4. Unistrut Corporation.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:
1. Concrete inserts shall be MSS SP-58 malleable Type 18.
1. Concrete inserts shall be of the continuous type capable of supporting 2,000 pounds per foot of insert as shown on the Drawings.
2. Product and Manufacturer: Provide one of the following:
a. Unistrut Corporation.
b. Elcan Metal Products.
c. ITT Grinnell.
d. B-Line.

C. Inserts for Pipe Insulation:
1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gage to carry the weight of the pipe and its fluid without deforming shall extend 2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP-58 Type 40 and for sizes over 10-inches shall be MSS SP-58 Type 39.

E. Brackets:
1. Brackets for wall mounting shall be MSS SP-58 Type 32.

2.4 PAINTING

A. Clean and shop prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09 90 00, Painting and Coating.

B. Field painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
   1. Temperature differential as specified in this Section.
   2. Support piping independently so that equipment is not stressed by piping weight or expansion/contraction.
   3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
   4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
   5. Maximum spacing for horizontal piping:
      a. Refer to table in Paragraph 2.1.A.9, above.
      b. Additional supports at:
         1) Change in direction.
         2) Branch piping and runouts over five feet.
         3) Concentrated loads due to valves, strainers and other similar items.
      c. Maximum support spacing for plastic pipe at ambient temperature shall conform to the requirements of the table located in Paragraph 2.1.A.9., above, unless otherwise shown on the Drawings.
   6. Hanger types for horizontal piping, except as noted and shown on the Drawings:
      a. Forged steel adjustable clevis type, rod support for all service.
      b. Slide Bases:
         1) Pipe stand, brackets, trapeze or other equivalent structural support.
         2) For piping 2-inches or larger.
      c. For pipe and covering provide:
         1) Saddles for rollers or slide bases.
         2) Protective shields or saddles for all other types of supports.
      d. Threaded Steel Rods:
         1) Two inch vertical adjustment with two nuts at each end for positioning and locking.
         2) Size hanger rods according to the schedule below, unless otherwise noted on the Drawings:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

3) For Double Rod Hangers: One size smaller than above.
4) Connection to Structure for Piping to 2-Inches: Concrete inserts in shear into sides of beams.
5) Connection to Structure for Piping 2-1/2 Inches or Larger: Concrete inserts, beam clamps or suitable bridging.

7. Vertical Piping:
   a. Base Support: Base elbow or welded equivalent.
      1) Bearing plate on structural support.
   b. Guides not to exceed:
      1) Twenty five feet for piping to 2-inches.
      2) Thirty six feet for piping 2-1/2-inches or larger.
      3) Ten feet for chlorination piping.
   c. Top Support:
      1) Special hanger or saddle in horizontal connection.
      2) Provisions for expansion/contraction.
   d. Intermediate Supports: Steel pipe clamp at floor.
      1) Bolted and welded to pipe.
      2) Extension ends bearing on structural steel or bearing plates.
   e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.
8. Insulated Piping:
   a. Horizontal Pipe Shields at Supports:
      1) Minimum 120 degree arc.
      2) Length equal to diameter of insulation, 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG stainless steel.
   b. Vertical Pipe Shields at Guides:
      1) Full 360 degree arc, securely banded.
      2) Length equal to diameter of insulation, 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG stainless steel.

D. Install items to be embedded before concrete placement.

E. Fasten embedded items securely to prevent movement during concrete placement.

F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations and instructions.

G. Adjust hangers, supports, pipe guides and anchors and place grout for concrete supports to bring pipelines to specified elevations.

H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

+ + END OF SECTION + +

SECTION 22 11 16

POTABLE WATER PIPING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, material, equipment and incidentals as shown on the Drawings, specified and required to furnish and install a complete and workable system of potable water piping including all piping, valves, and accessories to the limits shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
      a. Phoenix Plumbing Code.
      b. Uniform Standard Specification for Public Works Construction by the Maricopa Association of Governments (MAG), as supplemented by the City of Phoenix.
   2. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI A13.1, Identification of Piping Systems.
   2. ANSI B16.3, Malleable Iron Screwed Fittings, 150 and 300 lb.
   3. ANSI A21.4, Cement-Mortar Lining for Cast-Iron and ductile Cast-Iron Piping for Water and Other Liquids (AWWA C105).
   4. ANSI A21.10, Gray-Iron and Ductile-Iron Fittings, 2 in. through 48 in., for Water and Other Liquids (AWWA C110).
   5. ANSI A21.11, Rubber Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings (AWWA C111).
   6. ANSI A21.51, Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids (AWWA C151).
   7. ANSI B16.1, Cast Iron Pipe Flanged Fittings, Class 25, 125, 150 and 800.
   8. ANSI B16.3, Malleable-Iron Screwed Fittings, 150 and 300 lb.
   9. ANSI B16.5, Steel Pipe Flanges, Flanged Valves, and Fittings.
   10. ANSI B16.15, Cast Bronze Threaded Fittings, 125 and 250 lbs.
   11. ANSI B16.18, Cast Bronze Solder Joint Pressure Fittings.
   12. ANSI B16.22, Wrought Copper and Bronze Solder-Joint Pressure Fittings.
   13. ANSI B16.24, Bronze Flanges and Flanged Fittings, 150 and 300 lbs.
   14. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   15. ANSI B125.2, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Pipe for Ordinary Uses, (ASTM A 120).
   16. ANSI H 23.1, Seamless Copper Water Tube, (ASTM B 88).
   17. ANSI H27.1, Seamless Red Brass Pipe, Standard Sizes (ASTM B 43).

18. ASTM A 53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless Pipe.
19. ASTM A 183, Specification for Carbon Steel Track Bolts and Nuts.
20. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
21. ASTM A 449, Specification for Quenched and Tempered Steel Bolts and Studs.
22. ASTM B 32, Specification for Solder Metal.
23. ASTM B 813, Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
24. ASTM D 1330, Specification for Rubber-Sheet Gaskets.
25. ASTM D 2000, Classification System for Rubber Products in Automotive Applications.
26. FS O-F-506B, Flux, Soldering: Paste and Liquid.
27. FS WW-U-531C, Unions, Pipe; Steel or Malleable Iron; Threaded Connection.
28. FS WW-U-516, Unions, Brass or Bronze; 250 pound.
29. PDI WH-201, Covering Certification, Sizing Placement and Reference Data for Water Hammer Arresters.
30. NSF/ANSI 61, Drinking Water System Components Health Effects.
31. Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing plumbing piping systems with the following minimum working pressure ratings, except where indicated otherwise:
   1. Water Distribution Systems, Below Ground: 80 psig.
   2. Water Distribution Systems, Above Ground: 80 psig.

1.4 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturers literature, specifications, and engineering data including dimensions, size and materials for the following:
      a. Pipe and Fittings.
      b. Valves.
      c. Backflow Preventers including assembly of parts lists.
      d. Strainers.
      e. Water Meters.
      f. Dielectric Couplings.
      g. Flexible connectors.
      h. Vacuum Breaker.
      i. Water Hammer Arresters.
      j. Hose Bibbs and Couplings.
      k. Thermometers.
      l. Pressure Gages.
      m. Pressure Reducing Valves.
      n. Air Release Valves.
      o. Service Sink.
      p. Janitor's sink.
      q. Other materials and equipment requested by ENGINEER.

2. Detailed 1/4-inch scale drawings showing materials and dimensions of the complete water piping systems, in plan and in section.
3. Guarantees.
4. Certificate of Compliance with NSF/ANSI 61 standard or with Arizona Administrative Code R18-4-119, in accordance with Section 11 00 00 requirements.

B. Record Drawings: Provide as specified in Section 01 78 39, Record Document.

C. Operation and Maintenance Manuals:
1. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.5 JOB CONDITIONS

A. Protection: Properly plug or cap the open ends of all pipe at the end of each days Work or other stopping point throughout construction. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury.

B. All excavation and backfill required for underground piping installed under this Section shall conform to Section 33 05 05, Buried Piping Installation.

C. Provide water meter rig and reduced pressure zone backflow preventer rig in accordance with requirements of local water company.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper Water Tube:
1. Tube:
   a. Reference: ANSI H23.1, ASTM B88.
   b. Type: K or L.
   c. Temper: Hard-drawn or soft-annealed.
2. Fittings:
   a. Reference: ANSI B16.22.
   b. Reference: ANSI B16.26.
   c. Reference: ANSI B16.18.
3. Joints:
   a. Sweat:
      1) Solder Metal: ASTM B 32.
      2) Flux: FS O-F-506, Type 1.
   b. Flanged:
      1) Flanges: ANSI B16.24, 150 lb. class.
      2) Gaskets: Red rubber, ASTM D1330, Grade 1, 1/8-inch thick.
      3) Nuts and Bolts: ASTM A 307.
4. Unions:
   a. Reference: FS WW-U-516.
   b. Material: Bronze.
   c. Rating: 250 pound W.O.G.

B. Dielectric Couplings:
   1. Type: Union or flange.
   2. Product and Manufacturer: Provide one of the following:
      a. Watts Regulator Co.
      b. Epco Sales Inc.
      c. Or equal.
   3. Ratings:
      a. Unions: 250 psi, ANSI B16.39.
      b. Flanges: 175 psi, ANSI B16.42 (iron), ANSI B16.24 (Bronze).

2.2 VALVES

A. Bronze Body Globe Valves:
   1. Type: Composition disc, union bonnet.
   2. Materials: Brass and bronze.
   3. Rating: 150 lb. SWP.
   4. End Connections: Solder joint.
   5. Product and Manufacturer: Provide one of the following:
      a. Stockham Valves and Fittings, Fig. No. B-24.
      b. Lunkenheimer Co., Fig. No. 126.
      c. Or equal.

B. Bronze Body Check Valves:
   1. Type: Swing, regrinding bronze disc, screw-in cap.
   2. Materials: Brass and bronze.
   3. Rating: 150 lb. SWP.
   4. End Connections: Solder joint.
   5. Product and Manufacturer: Provide one of the following:
      a. Stockham Valves and Fittings, Fig. No. T-285.
      b. Lunkenheimer Co., Fig. No. 2145.
      c. Or equal.

C. Bronze Body Ball Valves:
   1. Type: Non-blowout stem, adjustable packing gland, quarter turn, full port ball valve.
   2. Materials:
      a. Body: Cast bronze.
      b. Ball: Chrome plated brass.
      c. Packing and Seats: Teflon.
   3. Rating: 150 lb. SWP.
   4. End Connection: Screwed. Provide screwed to sweat adapters where required.
   5. Product and Manufacturer: Provide one of the following:
      a. Stockham Valves and Fittings, Fig. S-217 BR-R-T.
      b. Lunkenheimer Co., Fig. 707-XLT.
      c. Or equal.

D. Bronze Body Gate Valves:
   1. Type: Rising stem, union bonnet solid wedge disc.
   2. Materials: Brass and bronze.
   3. Rating: 150 lb. SWP.

4. End Connections: Screwed.
5. Product and Manufacturer: Provide one of the following:
   a. Stockham Valves and Fittings, Fig. No. B-124.
   b. Lunkenheimer Co., Fig. No. 3155.
   c. Or equal.

E. Strainers:
1. Type: Self-cleaning "Y" body with blow-off cock.
2. Construction:
   a. Basket: Perforated stainless steel basket.
   b. Perforations: 0.045-inches diameter, minimum.
   c. Free Area: Four times cross sectional area of connecting pipe, minimum.
3. Strainers 2-1/2-inch and smaller:
   a. Materials:
      1) Body: Cast bronze.
      2) ASTM B-62.
   b. Pressure Rating: 250 psi steam at 425°F temperature.
   c. End Connections: Solder ends or screwed ends with adapters for screw to sweat ends.
   d. Blowoff Connection: Unplugged, NPT blowoff connection.
4. Strainers 3-Inches and Larger:
   a. Construction:
      1) Body: Cast iron ASTM A-126B.
   b. Pressure Rating: 125 psi steam.
   c. End Connections: Flanged ANSI B16.1 drilling.
   d. Blowoff Connections: Tapped, NPT, unplugged.
5. Provide short nipple and blowoff valve for each strainer.
6. Product and Manufacturer: Provide one of the following:
   a. Mueller Steam Specialty Co.
   b. Armstrong Steam Specialty Co.
   c. Or equal.

F. Iron Body Gate Valves:
1. Type: Rising stem, outside screw and yoke, solid wedge.
2. Materials: Iron with bronze trim.
3. Rating: 125 lb. SWP.
4. End Connections: Flanged, ANSI B16.1 drilling.
5. Provide chainwheel operators for all valves above 5-foot 6-inches above floor.
6. Product and Manufacturer: Provide one of the following:
   a. Stockham Valves and Fittings, Fig. No. G-623.
   b. Lunkenheimer Co., Fig. No. 1430.
   c. Or equal.

G. Iron Body Check Valves:
1. Type: Swing, regrind-renew disc and seat ring, bolted cover.
2. Materials: Iron body, bronze trim, bronze disc and seat ring.
3. Rating: 125 lb. SWP.
4. End Connections: Flanged, ANSI B16.1 drilling.
5. Product and Manufacturer: Provide one of the following:
   a. Stockham Valves and Fittings, Fig. No. G-931.
   b. Lunkenheimer Co., Fig. No. 1790.

c. Or equal.

2.3 EQUIPMENT

A. Hose Bibbs, Pipe Drains:
1. Valve:
a. Type: Boiler drain globe valve, chrome plated.
b. Material: Bronze body, screwed bonnet, renewable composition disc.
c. End Connections: Hose thread outlet, male pipe thread or sweat inlet.
d. Rating: 125 lbs. WOG.
2. Vacuum Breaker:
a. Type: Non-removable, atmospheric.
b. Materials: Brass body, stainless steel trim, silicone rubber diaphragm and disc.
c. End Connections: Hose thread inlet and outlet.
3. Product and Manufacturer: Provide one of the following:
a. Woodford Manufacturing Co., Model 24C.
b. Nibco Inc., Fig. No. 74VB.
c. Or equal.

B. Water Hammer Arresters:
1. Materials:
a. Casing: Stainless steel.
b. Bellows: Stainless steel.
c. Bellows Contents: Nitrogen gas.
2. Connection: Male NPT thread.
3. Maximum Working Pressure: 250 psig.
4. Sizing and Certification: P.D.I. WH-201.
5. Product and Manufacturer: Provide one of the following:
a. Hydrotrol by Jay R. Smith Manufacturing Co.
b. Shoktrol by Zurn Industries.
c. Or equal.

C. Pipe Labels:
1. Type: Self-adhering, temperature resistant, waterproof, corrosion resistant.
2. Marker size, marker color, legend size, and legend color shall conform to ANSI A13.1.

D. Flexible Connections:
1. Type: Flexible connections for piping 2-1/2-inches and smaller.
2. Construction:
a. Hose: Bronze.
b. Braid: Bronze.
3. Pressure Ratings: 190 psig working pressure at 250°F temperature.
4. End Connections: Solder end welded to hose and braid ends.
5. Product and Manufacturer: Provide one of the following:
a. Flexonics Inc.
b. Anaconda Metal Hose Division, Anamet Incorporated.
c. Or equal.

E. Automatic Air Vents:

1. Type: Automatic vent air eliminator with built-in air chamber.
2. Construction:
   a. Body: Bronze.
   b. Finish: Chrome plated exterior.
   c. Overflow Connector: Provide connection for 1/4-inch O.D. copper tubing.
3. Ratings: 75 psig working pressure.
4. Product and Manufacturer: Provide one of the following:
   a. Bell and Gossett.
   b. Armstrong Pump Co.
   c. Or equal.

F. Pressure Gages:
   1. Reference Division 40, Specification 40 70 00

G. Backflow Preventers: 1/2-Inch to 2-Inches:
   1. Type: Reduced pressure zone device with two independently acting check valves, together with an automatically operated pressure differential relief valve located between the two check valves.
   2. Materials:
      a. Body: Bronze.
      b. Valve Discs: EPT rubber.
      c. Diaphragm: Buna-N and nylon.
      d. Springs: Stainless steel.
      e. Screws: Stainless steel.
   3. Maximum Working Pressure: 150 psi.
   4. End Connection: Screwed.
   5. Accessories:
      a. Air gap drain funnel with threaded outlet and vent elbow furnished by manufacturer.
      b. Strainer with blowoff on inlet.
      c. Ball valves on inlet and outlet.
      d. Reduced pressure principle backflow preventer test kit for each unit furnished, provided in molded plastic carrying case with foam inserts.
   6. Product and Manufacturers: Provide one of the following:
      a. Conbraco Industries, Incorporated, Series 40-200.
      b. Hersey Products, Aergap Model FRP-II.
      c. Febco, Model 825Y.
      d. Watts Regulator Co., Series 909.
      e. Or equal.

H. Water Meter:
   1. Type: Magnetic Drive, disk water meter.
   2. Materials:
      a. Body: Bronze.
      b. Register: Brass.
      c. Gear Train: Self lubricating celcon plastic.
   3. Maximum Working Pressure: 150 psi.
   4. End Connection: Flanged.
   5. Product and Manufacturers: Provide one of the following:
      a. Hersey Products Inc., Model MHD.
      b. Neptune Water Meter Co., Model T-10.

c. Or equal.

I. Vacuum Breakers:
1. Pressure Type: PVB:
a. Type: An assembly containing an independently operating internally loaded check valve and an independently operating loaded air inlet valve located on the discharge side of the check valve. The assembly shall also be equipped with test cocks and shut off valves on the inlet and outlet of the assembly.
b. Materials:
1) Hood: Stainless steel.
2) Bonnet: Bronze.
3) Vent Disc: Silicone rubber.
4) Disc Holder Float: Polyethylene.
5) Check Valve Disc: Silicone rubber.
6) Check Valve Seat: Bronze.
7) Body: Bronze.
c. Accessories:
1) Ball valves on inlet and outlet.
2) Ball valve test cocks.
d. Reference: ASSE Standard No. 1020.
e. Working Pressure: 150 psi.
f. Installation: Vertical, minimum 12-inches above fixture vacuum breaker serves.
g. Product and Manufacturer: Provide one of the following:
1) Watts Regulator Co., No. 800.
2) Conbraco Industries Inc., Series 40-500.
3) Febco, Model 765.
4) Or equal.
2. Atmospheric Type: AVB:
a. Type: An assembly containing an air inlet valve, a check seat and an air inlet port to prevent reverse flow of water and allow air into the water line to break a siphon.
b. Materials:
1) Hood: Bronze.
2) Body: Bronze.
3) Vent Disc: Silicone.
4) Disc Holder Float: Polyethylene.
5) Body: Bronze.
c. Reference: ASSE Standard No. 1001.
d. Working Pressure: 125 psi.
e. Installation: Vertical, minimum 6-inches above fixture vacuum breaker serves.
f. Product and Manufacturer: Provide one of the following:
1) Watts Regulator Co., No. 288A.
2) Conbraco Industries Inc., Series 38.
3) Febco, Model 710/715 as required.
4) Or equal.

J. Hose Reels:
1. Type: Continuous flow hose reel.

2. Materials:
   a. Rims: Tubular steel, welded.
   b. Spokes: 3/8-inch diameter steel rods.
   c. Frame: Heavy steel bar frame.
   d. Drum: Galvanized steel.
   e. Finish: Baked enamel.
3. Connections: 1-inch inlet and outlet.
4. Threads: 1-inch N.S.T.
5. Product and Manufacturer: Provide one of the following:
   a. Crocker-Standard, Fig. No. 7025.
   b. Potter Roemer Inc., Fig. No. 2838.
   c. Or equal.

K. Hose Nozzles:
1. Materials:
   a. Body: Lexan.
   b. Stem: Brass.
   c. Bumper: Rubber.
2. Threads: 1-inch N.S.T.
3. Nozzle: Adjustable fog nozzle, capable of complete shut-off, solid straight stream, or any degree of solid conical fog.
4. Product and Manufacturer: Provide one of the following:
   a. Crocker-Standard, Fig. No. 3477.
   b. Potter Roemer Inc., Fig. No. 2959.
   c. Or equal.

L. Hose:
1. Type: Double braided synthetic hose for use with continuous flow reels to permit flow while hose is coiled on reel. Couplings shall connect to hose nozzle threads and male hose outlet threads on hose reel.
2. Threads: 1-inch N.S.T.
3. Hose Size: 1-inch.
4. Length: One continuous length as shown on Drawings with no intermediate couplings.
5. Product and Manufacturer: Provide one of the following:
   a. Croker-Standard, Fig. No. 7037 with brass coupling for non-collapsible hose.
   b. Potter Roemer, Fig. No. 2852 hose with Fig. No. 2862 coupling.
   c. Or equal.

M. Quick Coupler Connections:
1. Type: Cam arms lock into adaptor groove.
2. Materials: Adaptor and Coupler:
   a. Body: Stainless steel.
   b. Cam arms: Stainless steel.
   c. Gaskets: Buna N.
3. Ends: Socket weld quick connect adaptor for connection to copper tubing; hose shank quick connect coupler.
4. Reference: MIL-C-27487.
5. Product and Manufacturer: Provide one of the following:
   a. Dover Corp., OPW "Kamlok" 633 series.

b. Or equal.

2.4 MATERIAL SELECTION

A. All potable water supply, hot, and cold piping 2-1/2-inches and smaller, run within the interior of a building, shall be hard-drawn copper Type "L" with solder joints and connections.

B. All potable water piping 2-1/2-inches and smaller run underground shall be soft-annealed copper Type "K" copper tubing.

C. All underground water piping 3-inches and larger shall be cement-lined ductile iron pipe with mechanical joints.

D. All water piping 3-inches and larger run within the interior of a building, shall be cement-lined ductile iron pipe with flanged or grooved joints.

E. All exposed water piping and valves to plumbing fixtures shall be chrome plated brass.

F. All valves for copper piping shall be bronze bodied, unless otherwise specified.

G. All valves for ductile iron piping shall be iron bodied, unless otherwise specified.

2.5 NSF APPROVAL

A. All materials or products which can contact drinking water, or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of piping shall be in accordance with Section 22 00 11, Installation of Plumbing Piping

B. All piping shall be pitched to facilitate draining. Drain valves shall be provided at system low points.

C. Harnessed flexible couplings or pipe loops shall be provided on all piping subject to thermal expansion and where piping 3-inches and larger crosses building expansion joints.

D. Unions shall be provided for all screwed piping at connections to equipment and at convenient locations to permit disassembly of piping.

E. All connections between ferrous and non-ferrous piping materials shall be made with dielectric couplings.

F. Care shall be taken so as not to leave tool marks or abrasions on plated, polished or soft metal piping.

G. Wherever changes in sizes of piping occur, changes shall be made with reducing fittings. The use of bushings is not permitted, unless otherwise shown on the Drawings.

H. All exposed unfurred pipes, whether insulated or not, shall be identified with pipe labels and the direction of flow indicated. Labels may be omitted from piping where the use is obvious, due to its connection to fixtures and where the appearance would be objectionable in finished rooms; as approved by the ENGINEER. Identification labels shall be placed as follows:
   1. Near each valve and branch connection.
   2. Wherever piping emerges or disappears from view, when viewed from the floor of the room in which it is installed.
   3. At not more than 25-foot intervals.

I. All pipes passing through ceilings, floors and walls in finished rooms, and all supplies to fixtures shall have escutcheon plates.

J. Pressure gage ranges shall be selected for proper sensitivity, so that the dial indicator points to the approximate center of the dial in normal operation.

K. Provide valved blow-off connections for each strainer.

L. Remove each fine mesh start-up strainer screen and replace with final stainless steel strainer screen after 30 days of operating time.

M. Conform to applicable requirements in Section 22 00 11, Installation of Plumbing Piping.

N. Provide shutoff valves to each piece of equipment furnished.

O. Every section of branch supply and return piping and all risers of all services shall be controlled by a valve at the main.

3.2 PREPARATION

A. Disinfection: Conform to Section 22 01 10.52, Disinfection, Plumbing.

3.3 FIELD QUALITY CONTROL

A. Tests: Pressure test all systems in conformance with Section 22 01 10.52, Disinfection, Plumbing, and Section 22 00 12, Testing of Plumbing Piping Systems.

3.4 CLEANING

A. Remove all debris, dirt and waste materials resulting from installation.

B. Remove dirt, dust, rust, etc. from piping in preparation for painting, testing and insulating.

C. Clean lenses on thermometers, pressure gauges, etc. where required.

+ + END OF SECTION + +

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform the testing, adjusting and balancing of HVAC systems.

1.2 QUALITY ASSURANCE

A. Balancer's Qualifications:
   1. Submit biographical data on employee proposed to directly supervise the testing, adjusting and balancing Work.
   2. Submit proof of certification by NEBB (National Environmental Balancing Bureau), AABC (Associated Air Balance Council), or SMACNA (Sheet Metal and Air Conditioning Contractors' National Association), proof of registration in the State of Arizona and a record of at least five years experience in the testing and balancing contracting industry, engaged in heating, ventilating and air conditioning (HVAC) Work.

1.3 SUBMITTALS

A. Data Forms:
   1. Submit data forms on each item of testing equipment required. Include name of device, manufacturer's name, model number, latest date of calibration, and correction factors.
   2. All field data pertaining to each item of equipment being tested must be tabulated and submitted on the standard forms of NEBB, AABC, or SMACNA.
   3. Sign and date each form in the space provided and proof of certification shall accompany the final report.

B. Report Forms:
   1. Submit specimen copies of report forms for ENGINEER'S approval.
   2. Forms shall be 8-1/2 by 11-inch paper for loose-leaf binding, with blanks for listing of the required test ratings and for certification of report.
   3. Reports shall be on the organizations approved forms imprinted with the company's name.
   4. Certified report outlining procedure used to balance the system and the types of measuring devices used.

C. Test results shall be submitted on approved forms in a typed format.

D. Submit three certified copies of required test reports to the ENGINEER for approval.

E. Valve Charts: Two required.

1. Frame and Glazing: 1/8-inch sheet acrylic in 8-1/2 by 11-inch extruded aluminum frame.
2. Charts: Typed with the following information for each valve:
   a. Valve identification number.
   b. Valve location.
   c. Valve use.
   d. Valve size.
   e. Manufacturers' name and model number.
3. Valve Tags: Submit sample of valve tag with sample identification lettering.

1.4 JOB CONDITIONS

A. Heating, ventilating and air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the testing, adjusting and balancing Work specified.

B. Testing, adjusting and balancing shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions.

1.5 OPERATING INSTRUCTIONS

A. Reports shall be certified by CONTRACTOR verifying that the methods used and the results achieved are as specified.

1.6 CORRECTIVE ADJUSTMENTS

A. Should corrective measures caused by faulty installation require retesting, adjusting and balancing, such Work shall be performed by CONTRACTOR, at no additional cost to the OWNER.

B. Inspections:
   1. Fan Belt Deflection: No less than 1/4-inch or more than a 1/2-inch.
   2. Finned Coils: Fins shall be combed out with a fin comb for appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

PART 2 - PRODUCTS

2.1 BALANCING INSTRUMENTATION

A. Provide all necessary instrumentation, tools, ladders, etc. to complete all air balancing, tests and adjustments.

B. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards stipulated by these organizations.

C. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.

D. Assume full responsibility for safe keeping of all instrumentation during the course of the Work.

2.2 CMMS TAGS

A. Provide CMMS Tags as specified under Section 01 93 13.15.

B. Piping Markers: Provide piping markers as specified under Section 09 90 00.

PART 3 - EXECUTION

3.1 GENERAL

A. Testing, adjusting, and balancing of air systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with CONTRACTOR. Submit one copy of the standard procedure manual to the ENGINEER for record purposes only.

B. Sole responsibility for the protection and safeguarding of the Work and providing every protection against accidents, injury, and damage to persons and property belongs to CONTRACTOR.

C. Keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.

D. Full responsibility for removal and reinstallation of ceiling system and replacement of any component damaged belongs to CONTRACTOR.

E. Install additional access panels, at no additional cost to the OWNER, as required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.

F. Air systems shall be tested, adjusted, and balanced with clean filters.

G. Hydronic systems shall be tested, adjusted, and balanced with clean strainers.

3.2 INSPECTION

A. Pre-Startup Inspection:
   1. Verify proper equipment mounting and setting.
   2. Verify that control, interlock and power wiring is complete.
   3. Verify alignment of motors and drives.
   4. Verify proper piping connections and accessories.
   5. Verify that lubrication is completed.

B. First Run Observations:
   1. Verify direction of rotation.
   2. Verify setting of safety controls.
   3. Monitor heat build up in bearings.
   4. Check motor loads against manufacturer’s nameplate data.

C. Equipment Check:
   1. Verify proper overload heater sizes.

2. Verify function of safety and operating controls.
3. Verify proper operation of equipment.
4. Report on inspection, observation and checking procedures.

3.3 AIR SYSTEMS

A. Preliminary:
   1. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.

B. Central Systems:
   1. Test rpm for all equipment, including adjustment to each fan and air handling unit, and air conditioning unit to design requirements within the limits of mechanical equipment provided.
   2. Adjust or change drive sheaves as required to adjust actual cfm to scheduled cfm.
   3. Test and record motor voltages and running amperes, including motor manufacturer's nameplate data, and starter heater ratings for each unit as listed above.
   4. Make Pitot tube traverse of main supply, exhaust and return ducts, determine cfm at all fans and units and adjust fans and units to within five percent of design requirements.
   5. Test and record system suction and discharge static pressure.
   6. Test and adjust system for design outside air, cfm.
   7. Test and adjust system for design recirculated air, cfm.
   8. Test and record heating apparatus outdoor entering air temperatures, dry bulb.
   9. Test and record heating apparatus return air temperatures, dry bulb.
   10. Test and record heating apparatus mixed air temperatures, dry bulb.
   11. Test and record heating apparatus leaving air temperatures, dry bulb.
   12. Test and record cooling apparatus outdoor entering air temperatures, dry bulb and wet bulb.
   13. Test and record cooling apparatus return air temperatures, dry bulb and wet bulb.
   14. Test and record cooling apparatus mixed air temperatures, dry bulb and wet bulb.
   15. Test and record cooling apparatus leaving air temperatures, dry bulb and wet bulb.
   16. Record all fan and air handling unit speeds.
   17. Record air quantity delivered by each fan and air handling unit.

C. Distribution:
   1. Adjust volume dampers, control dampers, splitter dampers, air extractors, etc. to proper design cfm in main ducts, branch ducts, and zones.

D. Air Terminals:
   1. Identify each air terminal as to location and determine required flow reading.
   2. Test and adjust each air terminal to within tolerance of design requirements as listed below:
      a. Diffusers and Supply Registers: 0 percent to +10 percent.
      b. Return Registers: 0 percent to -10 percent.
      c. Exhaust Registers: 0 percent to -10 percent.

3. Test procedure on air terminals shall include recording comparison of required cfm and observed cfm, adjustment of terminal, and recording of final cfm.
4. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.

E. Verification:
1. Prepare summation of readings of observed cfm for each system, compared with required cfm, and verify that duct losses are within specified allowable range.
2. Verify design cfm at fans as described above.
3. If the air systems are not properly balanced, rebalance and recheck all data in the presence of ENGINEER and as approved by the ENGINEER.

3.4 AUTOMATIC CONTROL SYSTEM

A. In cooperation with the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Verify all controls for proper calibration and operation and list those controls requiring adjustment by control system installer.

3.5 SYSTEM PERFORMANCE REPORT

A. After the conclusion of balancing operations, make temporary installation of portable recorders and simultaneously record temperatures and humidity during summer and winter conditions at representative locations in each system inside and outside of building.

B. Test locations shall be as approved by ENGINEER.

C. Recordings shall be made during summer and winter seasons for a seven day period, continuous over a weekend, and including at least one period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition and within 10°F dry bulb temperature of minimum winter design condition. Design conditions shall be based on ASHRAE 2-1/2 percent weather data.

D. Report of test results shall include original recording and two reproductions.

E. Each test report shall include reference to the CMMS Tag Serial Key for the corresponding odor control fan, refer to Section 01 93 13.15.

3.6 MAINTENANCE AND REPAIR

A. Maintenance and Repair:
1. Provide all labor, tools and equipment to provide a Preventive Maintenance program. Make repairs for all equipment and controls for a one year period after final acceptance by OWNER. Provide the following services for the same one year period.
a. Receive calls for all problems and take steps to immediately correct deficiencies which may exist.

b. Provide inspection of all equipment, and record the findings on a check list hereinafter specified.
c. Provide a preventive maintenance schedule for the principle items of equipment.

B. Check List:
1. Provide a check list and post a copy of it, where directed by OWNER.
2. Include each piece of equipment specified or shown on the Drawings.
3. Provide columns for required inspections.
4. Provide columns for the following:
a. Equipment condition.
b. Equipment operation.
c. Equipment lubrication.
d. Preventive maintenance.
5. Preventive maintenance shall be performed in accordance with the manufacturer's recommendations and accepted practice.

3.7 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, minimum 8 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment and controls conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install a system of duct insulation complete with all appurtenances.

1.2 QUALITY ASSURANCE

A. General: Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following Fire Hazard Classifications in accordance with ASTM E 84:
   1. Flame spread, 25 maximum.
   2. Smoke developed, 50 maximum.

B. Source Quality Control: Perform the following tests and inspections at factory:
   1. Flame Spread.
   2. Smoke Developed.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Permits: Obtain and pay for all required permits, fees and inspections.
   2. American National Standards Institute, (ANSI).
   3. National Fire Protection Association, (NFPA).
   4. Underwriters' Laboratories, Incorporated. Fire hazard ratings to be verified by Underwriters' Laboratories, Inc. label, listing or a certified test report from an approved independent testing laboratory.
   5. Phoenix Building Code.
   6. Phoenix Mechanical Code.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   3. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   4. UL No. 723, Test for Surface Burning Characteristics of Building Materials.

E. Manufacturer's Markings:
   1. Stamp or label with manufacturer's name and brand every package or standard container of covering, adhesive and coating delivered to the job site for use.
   2. Exposed side of insulation shall be legibly labeled by the manufacturer to show thickness, type and manufacturer.

1.3 SUBMITTALS

A. Samples: Submit for approval samples of the following:
   1. Thermal Insulation - Flexible.
   2. Thermal Insulation - Rigid.

B. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog literature, specifications and illustrations with the following information:
      a. Thermal properties.
      b. Physical properties.
      c. Fire hazard ratings.
      d. Facing information.
      e. Installation instructions.
      f. Jointing recommendations for butt joints and longitudinal seams.
   2. Deviations from Contract Documents.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Material: Materials shall be delivered to job site in corrugated cartons.

B. Storage of Material:
   1. Store material in a clean, dry area out of the weather.
   2. Material shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.
   3. Material shall remain in original cartons till time of installation.

1.5 JOB CONDITIONS

A. Sequencing: Obtain the ENGINEER'S approval of insulation, adhesives, coatings and method of installation before installing any insulation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Thermal Insulation - Rigid:
   1. Type: Rigid fiberglass board with finished vapor barrier facing.
   2. Density: Six pounds per cubic foot.
   3. Facing: Foil reinforced Kraft.
   4. Thickness: 3-inch.
   5. Thermal conductivity: 0.22 BTU-inch/hr.-ft^2-°F @ 75°F mean temperature.

B. Thermal Insulation - Flexible:
   1. Type: Flexible fiberglass blanket with vapor barrier.
   2. Density: Minimum one pound per cubic foot.
   3. Facing: Aluminum foil reinforced with fiberglass yarn mesh and laminated to chemically treated, fire resistant Kraft paper.
   4. Thickness: 2-inch minimum.
   5. Thermal conductivity: 0.27 BTU-inch/hr.-ft^2-°F @ 75°F mean temperature.

C. Product and Manufacturer: Provide one of the following:
   1. Owens Corning.
   2. Schuller International, Inc.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Ensure that all surfaces are clean and dry before applying insulation.

3.2 PREPARATION

A. Ensure that ductwork has been inspected and released for application of insulation.

3.3 INSTALLATION

A. General:
   1. Install insulation so as to make surfaces smooth, even and substantially flush with adjacent duct insulation.
   2. Follow manufacturer's application instructions and recommendations for all materials used.
   3. Duct sizes as shown on the Drawings are clear inside dimensions. Increase duct sizes to provide designated inside dimensions when internal insulation is used.
   4. Duct insulation shall be continuous through sleeves and prepared openings.
   5. Insulation shall terminate at fire dampers and flexible connections.
   6. Vapor barrier materials shall be applied to form a complete unbroken vapor seal over insulation.

3.4 CLEANING

A. Remove all debris, waste materials and loose foreign matter resulting from installation.

3.5 SCHEDULE

A. Thermal Insulation - Flexible:
   1. All supply and return ductwork within the building.

B. Thermal Insulation - Rigid:
   1. All supply and return ductwork exterior to the building.
   2. Install 0.05 in thick minimum aluminum jacketing around all exterior rigid insulation. Overlap and seal all edges for a fully weatherproof installation.

+ + END OF SECTION + +

SECTION 23 09 33.11

AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install an electric/electronic system of automatic temperature controls complete with all appurtenances, including all accessories, components, hardware, etc., as necessary and required for a complete and operational system.

B. General:
1. Descriptions contained herein are for guidance and show the functions desired. They do not describe or specify all components required to interface equipment. All parts and equipment necessary to meet functional requirements shall be provided.
2. Control system manufacturer shall be completely responsible for the proper operation and functions of all control systems herein specified. Control system manufacturer shall be responsible for coordination of all interfaces with other contractors to achieve the required control operation.

C. Products Furnished Under this Section:
1. All conduit and wiring from HVAC control panels to respective packaged air to air heating pump units, indirect/direct evaporative cooling air handling units, fans, exhausters, dampers, valves, thermostats, temperature sensors, freezestats, HVAC System smoke exhausters, detectors, firestats, aquastats, controllers and remote HVAC malfunction alarms.
2. Motorized dampers and actuators, including linkage kits.
3. Thermostats, temperature controllers, aquastats, outdoor reset controls, including mounting accessories, pull boxes, face plates, wall plates, mounting hardware, etc., as required.
4. Freezestats, firestats, smoke detectors, including mounting accessories, pull boxes, etc., as required.
5. Relays, selector switches, push buttons, pilot lights, indicating lights, “HAND-OFF-AUTOMATIC” selector switches and all accessories located in the automatic temperature controls (ATC) panels.
6. Transformers where specified or required.
7. Motor starters where specified.
8. Remote common HVAC malfunction alarm.
9. Static pressure controllers, velocity controllers, probes, sensors, and all accessories.
10. Power disconnect switches where specified or required.
11. Control panels.
12. Control valves and actuators, including linkage kits.
13. Minimum position switches.
14. Variable air volume units.

15. Enthalpy controllers.
16. Time clocks.
17. All interlock wiring and conduit, unless shown on the Drawings.
18. Wiring and conduit from ATC panel to remote devices, as required. All systems requiring DC or isolation from AC wiring shall be provided under this Section. Each system shall include all conduit and wire for a complete and functional system.

D. Products Furnished Under Other Sections:
1. 480 volt, 3 phase power wiring and conduit under Division 26, Electrical.
2. 120 volt, single phase wiring and conduit under Division 26, Electrical.
3. Starters shall conform to Division 26, Electrical.

1.2 QUALITY ASSURANCE

A. Standards of Workmanship: All materials, equipment and installation shall be in strict accordance with requirements of Division 26, Electrical.

B. Manufacturers Qualifications:
1. Manufacturer shall have a minimum of five years experience in producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
1. Underwriters' Laboratories, Incorporated (UL).
2. National Fire Protection Association (NFPA).
3. Phoenix Building Code.
4. Phoenix Mechanical Code.
5. National Electrical Code (NEC) current adoption.
6. City of Phoenix – Amendments to the Nation Electrical Code.

D. Source Quality Control:
1. Motorized dampers shall allow a maximum air leakage of 16 cfm per square foot at 4-inches water gage static pressure.

E. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Phoenix Electrical Code.
2. Standards of National Electric Manufacturers Association (NEMA).
3. Institute of Electrical and Electronic Engineers (IEEE).
4. International Society for Measurement and Control (ISA).
5. National Fire Protection Association (NFPA).
6. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. All items of equipment furnished under this Section.

2. Control schematics conforming to NFPA 79, Annex “D” Standards. Complete control schematic and point-to-point internal and external wiring diagrams. Separate control schematics shall be provided for each panel.
3. Manufacturer’s literature, illustrations, specifications, engineering data, and catalog cuts.
4. Sequence of operation description.
5. Damper test reports.
6. Panel drawings.
7. Graphics for control panels.
8. Control valve schedule which includes:
   a. Valve size.
   b. C_V value.
   c. Design flow rate (gpm).
   d. Location and unit served.
9. All devices submitted shall be cross-referenced and labeled with project designations.

B. Submit written confirmation that control systems will be fully compatible and interface properly with all equipment, control components and software furnished under this Contract.

C. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Product and Manufacturer: Provide product(s) of one of the following:
   1. Johnson Controls Inc.
   2. Honeywell Inc.
   3. Barber Colman Co.
   4. Or equal.

2.2 THERMOSTATS, TEMPERATURE CONTROLLERS, AND SENSORS

A. Type: Electronic Programmable Thermostat:
   1. Seven day programming with completely independent single occupied/unoccupied time schedule for each day of the week.
   2. Light emitting diode (LED) prompted programming.
   3. Individual temperature setpoints for:
      a. Occupied: Heating, economizer, and cooling.
      b. Unoccupied: Heating (low limit), economizer, and cooling (high limit).
   4. Intelligent recovery maximizes energy savings by automatically optimizing startup time depending on building load.

5. Intelligent setpoint maximizes energy savings and occupant comfort in economizer systems by controlling space temperature from a lower economizer setpoint when outdoor air is suitable for economizer mode.
6. Soft start minimizes utility demand peaks during intelligent recovery period by ramping the setpoint.
7. Economizer precooling maximizes energy savings by using cool outdoor air during intelligent recovery.
8. Intelligent fan operation during unoccupied periods saves energy by closing outdoor air dampers and energizing the fan only on a call for heating/cooling.
9. Systems provide precise temperature control over all load conditions, eliminating temperature fluctuations and energy wasting thermostat tampering.
10. Locking cover provides keyboard security and tamper resistance.
11. Battery backup saves program and maintains clock time during power failure, and default setpoints provide further system integrity.
12. Self-diagnostics inform user of error conditions.
13. Built in HVAC equipment protection with minimum stage on and off times to prevent short cycling.
14. Three hour override of unoccupied program accessible without opening cover and automatic return to programmed scheduling. Continuous unoccupied key maximizes savings during holidays and vacations without changing programmed setpoints.
15. Keyboard selectable display of either continuous time or temperature.
16. Automatic heat/cool changeover allows operation to meet demand.
17. Setpoint Temperature Range: 32°F to 99°F.
18. Electrical Rating: 24 VAC.
19. Provide remote space temperature sensor where specified.
20. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

B. Type: Space Thermostat:
1. Application:
    a. Heating.
    b. Fan switching.
    c. Evaporative cooling staging.
2. Mercury switches activated by vapor filled bellows.
3. Thermostat Setpoint Range: 60°F to 100°F.
4. Electrical Rating: 120 VAC.
5. Integral thermometer.
6. Adjustable setpoints through dial on face.
7. Contacts shall have proper ampere rating for intended use.
8. Rugged clear plastic locking cover.
9. Switching subbase to provide "ON-OFF-AUTO" switching at thermostat.
10. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

C. Type: Proportional Thermostats:
1. Application: Proportional control of modulating valves and dampers.
2. Electrical Rating: 24 VAC.
3. Thermostat Range: 63°F to 87°F.

4. Temperature setting scale with removable setting knob on cover.
5. Adjustable proportioning ranges.
6. Vapor filled operating bellows.
7. Controls two motors in unison or in sequence.
8. Rugged clear plastic locking cover.
9. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

D. Type: Low limit thermostats-freezestats:
1. 20-foot temperature averaging element.
2. Adjustable Setpoint Range: 20°F to 60°F.
3. Manual reset.
4. Electrical Rating: 120 VAC.
5. Fast response.
6. Thermostat responds to lowest temperature sensed by any one foot section of element.
7. Dustproof and moisture proof snap switch.
8. Metal case with removable cover.
9. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

E. Type: High Limit Thermostats (Firestats):
1. Helical bimetal insertion element.
2. Adjustable Setpoint Range: 50°F to 165°F.
3. Manual reset.
4. Fast response.
5. Electrical Rating: 120 VAC.
6. Metal case with removable cover.
7. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

F. Type: Outdoor Thermostat:
1. Copper liquid filled bulb with capillary tube for remote mounting of sensing element.
2. Electrical Rating: 120 VAC.
3. Setpoint Range: 0°F to 100°F.
4. Differential: 3°F to 10°F.
5. Adjustable setpoint though knob on cover.
6. Provide sunshield for sensing bulb as required.
7. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

G. Type: Electronic Indoor/Outdoor Proportional Controller:
1. Application: Hot water heating system loop water temperature controller.
2. Seven day programmable quartz clock with 50-hr battery backup for programmable setback schedules.
3. Solid state balance circuit provides proportional plus integral (P&I) control.

4. Selectable parallel adjustment.
5. Adjustable motor timing to one or four minutes.
6. 120 VAC input with 120 VAC or 24 VAC output.
7. Reset ratio adjustable from 1:3 to 2.5:1 (ratio of change in outdoor air temperature to change in heating loop water temperature) preset at 1:1.
8. Indicating LEDs on panel show when three-way valve is opening or closing.
9. Provide loop water immersion sensors and outdoor temperature sensors with sunshield.
10. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

H. Type: Air Temperature Sensor:
1. Carbon type, negative temperature coefficient (NTC) thermistor sensing element.
2. Rugged aluminum insertion probe.
3. Solid state components not affected by dust or dirt.
4. Fast reacting.
5. Operating Range: 40°F to 150°F.
6. Used in conjunction with system logic panel to stabilize system output.
7. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

2.3 ENTHALPY CONTROLLERS

A. Solid State Enthalpy Controller and Sensors:
1. Permits use of outdoor air (free cooling) based on temperature and humidity sensors in outdoor and return air streams.
2. Controls outdoor air, return air and relief air dampers.
3. Mounting plate and wiring compartment.
4. Humidity Sensing Element: Capacitive film.
5. Temperature Sensing Element: Thermistor.
6. Switching Action: SPDT.
7. Temperature Ratings: Operating ambient, -25°F to 125°F.
8. Dial Settings: A, B, C and D set temperature and relative humidity curves.
9. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

2.4 LOGIC PANELS AND INTERFACE MODULES

A. Type: Logic Panel:
1. Application: Solid state energy management system controls heating, cooling, and economizer operation.
2. Integrated economizer provided as the first state of cooling.
3. Positive modulating low limit starts to close economizer damper to minimum position if discharge air temperature drops below factory set temperature of 62°F. Damper will be at minimum position when discharge temperature is 50°F.

4. Discharge air sensor provides anticipation and a positive economizer modulating low limit signal.
5. Balances system output against space load demand to maintain stable room temperature with minimum temperature swing.
6. System recycles to all states off, on power interruption. System sequences stages back on with a time delay between stages, when power is restored.
7. 1/4-inch male quick connect terminals provided for wiring connections.
8. Pilot duty SPDT relays control on/off heating and cooling stages.
9. Modulating DC current signal controls economizer and valve motors.
10. Electrical Rating: 24 VAC.
11. Input Signal: 1 to 16 VDC.
12. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

B. Type: System Interface Module:
1. Application: Translates digital encoded information generated by an electronic programmable thermostat into DC heating and cooling control voltages.
2. Used in conjunction with system logic panel (Honeywell Inc., Series (--1--)).
3. Provides a compact method for time of day (TOD) scheduling, night setback, and intelligent recovery.
4. Product and Manufacturer: Provide one of the following:
    a. As manufactured by Honeywell Inc.
    b. Or equal.

2.5 ACTUATORS - DAMPERS AND VALVES

A. Type: Electric, spring return, two position:
1. Oil immersed gear train.
2. Line voltage or unit mounted low voltage control transformer.
3. Mechanical spring shall return actuator to normal position when de-energized.
4. Sufficient torque to operate louver, damper or valve furnished.
5. Two position.
6. Internal heater for outdoor locations only.
7. Limit switches.
8. Linkage kit, as required.
9. Electrical Rating: 120 VAC. Provide 120V/24V control transformers, where required.

B. Type: Electric, Reversing, Proportional:
1. Oil immersed gear train.
2. Line voltage or unit mounted low voltage control transformer.
3. Upon power interruption, actuator shall spring return to normal position.
4. Sufficient torque to operate louver, damper or valve furnished.
5. Electronic drive.
6. Internal heater for outdoor locations only.
7. Adjustable limit switches, where required.
8. Adjustable drive start point.
9. Linkage kits, as required.

C. Refer to Equipment Schedule as shown on the Drawings for data.

2.6 MOTORIZED CONTROL DAMPERS

A. Source Quality Control: Motorized dampers shall allow a maximum air leakage of 16 cfm per square foot at 4-inches water gage static pressure. Design for maximum 6-inches water gage static pressure differential and 4,000 feet per minute approach velocity.

B. Type: Reinforced Opposed Blade:
   1. Reference: SMACNA Standards.
   2. Construction: Tight seal ultra low leakage construction.
      a. Frame: 13 gage. Thickness of aluminum frame to be minimum 1/8-inch.
      b. Blades: 16 gage. Thickness of aluminum blades to be minimum 0.084-inch. All blades over 34-inches in width to be reinforced.
      c. Blade Shafts: 1/2-inch zinc plated steel.
   3. Provide neoprene rubber blade edge seals for air tight damper closure.
   4. Blade ends shall be sealed with spring loaded stainless steel continuous strips fastened to frame.
   5. Bearings: Oilite bearings at each end of shaft.
   6. Blades to be designed for minimal resistance to air flow.
   7. Zinc plated steel linkage brackets, connecting rods and mounting hardware.
   8. Product and Manufacturer: Provide one of the following:
      a. As manufactured by Honeywell Inc.
      b. Or equal.

2.7 MINIMUM POSITION SWITCH

A. Type: Manual potentiometer:
   1. Potentiometer assembly.
   2. Dial: 0 percent to 100 percent.
   3. Adjustment knob.
   4. Range: 0 percent to 100 percent minimum position.
   5. Electrical Rating: 120 VAC.

2.8 HVAC CONTROL PANELS (ATC Panels)

A. Furnish centralized control panels to house all HVAC equipment control devices, wiring and logics, as required. Panel shall include, but not limited to, the following items.
   1. "HAND/OFF/AUTO" switches, selector switches, "START/STOP" push-buttons, run indicating lights, system fail, etc. Fail lights shall consist of freeze and high temperature, smoke and individual motor overload.
   2. Local alarm circuit with flashing light and a common horn mounted on the top of the panel for smoke/fire, freeze, motor overload conditions. A panel mounted alarm indicator and manual reset button to require manual resetting of alarm conditions shall be provided. Separate alarm indicators and resets shall be provided for each system, when multiple systems are provided within a given panel. Circuit shall include provisions to silence bell.
   3. Relays, control wiring and accessories for all control logic requirements, as required, for the sequence of operation specified.

4. Provision for a remote common HVAC malfunction alarm, dry contact output shall be provided to signal the operator's terminal.
5. Provision for smoke purge system for air handling systems. System shall include a purge pushbutton and purge cycle indicator. When activated the purge cycle shall be active for and adjustable delay (0 to 60 min.) purge cycle shall allow system operation when smoke is detected. Separate purge systems shall be provided for each system when multiple systems are provided within the given panel.

B. All control logic/devices shall be provided within the ATC panels, including all necessary interfacing devices for control of remote components. Responsibility belongs to CONTRACTOR to fully coordinate each system requirement, including Division 26, Electrical, furnished items, to provide the proper sequence of operation and interconnection of all components as shown on the Drawings and specified.

C. Motor starters for supply fans, exhaust fans and water pumps are included in remote motor control centers provided under Division 26, Electrical. ATC panels shall contain all system logic and produce dry contact for interface of equipment.

D. Control panel shall be completely factory assembled and wired, including cabinet, components, wiring, terminal strips to facilitate final connections and with nameplates. Submit panel drawings and complete panel wiring diagrams to the ENGINEER for approval prior to fabrication. Panel construction shall conform to NEMA and Phoenix Electrical Code requirements.

E. Provide control panels as shown on the Drawings, and as specified in Division 40, Sections 40 06 70, 40 61 93, 40 61 96, 40 67 00 and 40 70 00.

F. Provide within panel all auxiliaries including switches, controllers, lights, timers, transmitters, as required for controls.

G. When required furnish subpanel for mounting control elements.

H. All indicators and control devices are to be flush mounted on door or face of cabinet and labeled with permanent nameplates of white lettering on black plastic.

I. All electrical controls located within the panel shall have electrical characteristics of 120 volts, 1 phase, 60 Hertz. Provide transformers in the control panel, as required. Each panel shall be equipped with an on/off main disconnect and control fuse.

2.9 LOCAL MALFUNCTION ALARMS (TOP PANEL MOUNTED)

A. Horn, 44 dBA at ten feet, and strobe light.

B. Flush mounting, vandal resistant construction, UL listed, with mounting plate and back box. Provide nameplate with 1/2-inch size letters to read "HVAC Malfunction Alarm", mount below plate.

C. Electrical Rating: 120 VAC, 1 phase 60 Hertz.

D. Provision to accept wiring from the HVAC control panels.

E. Product and Manufacturer: Provide one of the following:
   1. Pyrotronics.
   2. Or equal.

2.10 RELAYS, PUSHBUTTONS, SELECTOR SWITCHES, PILOT LIGHTS, INDICATING LIGHTS

A. Relays, pushbuttons, selector switches, pilot lights, indicating lights, and START/STOP switches, shall be in accordance with the requirements specified in Division 26, Electrical.

2.11 NAMEPLATES

A. Black laminated phenolic plastic with minimum 3/16-inch high white engravings.

B. Nameplates shall be affixed with stainless steel rivets or screws.

C. Nameplates shall be provided at all thermostats, timeclocks and control switches, providing information on unit being controlled.

D. Comply with the requirements of Section 01 93 13.15, Computerized Maintenance Management System Tag.

2.12 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide two sets of all special tools required for maintenance and operation.

2.13 MISCELLANEOUS

A. Provide manufacturers, remote sensors, low voltage terminal strips, damper and valve linkages, etc. as required to provide proper equipment control as specified in Article 3.2, below.

B. Provide all mounting accessories, as required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install freeze protection thermostats on the leaving air side of direct evaporative cooler section. Thermostat shall stop the air handling unit supply air fans if the leaving air temperature drops to the low limit setting.

B. Duct thermometers shall be legible from a standing position on the floor.

C. Install thermometers where specified herein and as shown on the Drawings at the following locations:
   1. Air Handling Units: Discharge air ducts.
   2. Heating and Cooling Coils: Supply and return water line to each coil.

D. Wall thermostats shall be installed five feet above finished floor. Wall plates, face plates and mounting hardware shall be provided as required for a complete installation.

E. Where thermostats must be located on exterior walls, provide an insulating mounting panel. Provide sunshield for outdoor located thermostats.

F. Furnish and install all mounting accessories, junction boxes, wall boxes and wall plates as required for installation of all thermostats and smoke detectors.

G. Where operable valves, or dampers are shown on the Drawings, provide sufficient motors to operate the operable louver, damper or valve as described in Article 3.2, below, or as shown on the Drawings.

H. Provide differential pressure gages for filter sections on each air handling system.

I. Provide and install all mounting hardware, controls and power wiring and conduit, and accessories as required for all field installed devices, including field-mounted thermostats provided with equipment.

3.2 ADJUSTING AND TESTING

A. Adjust all system components for specified operation.

B. Test each control system for proper operation.

3.3 MANUFACTURER'S SERVICES

A. Furnish services of a qualified factory-trained serviceman to assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations, place the systems in automatic operation and instruct plant operators in the care, operation and maintenance of the equipment.

B. The serviceman shall make a minimum of 3 visits, minimum 8 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be to assist field tests and initial operation. The fourth visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the automatic temperature controls conform to requirements. Manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. All costs, including travel, lodging, meals and incidentals shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 23 31 00

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install complete ductwork systems with all appurtenances required for proper operation.
   2. Field verify locations and elevations for all ductwork systems with existing conditions and route ductwork systems to clear obstructions.
   3. Items to be furnished and installed under this Section include, but are not limited to the following:
      a. Rectangular aluminum ductwork, fittings and accessories.
      b. Rectangular Type 304L stainless steel ductwork, fittings and accessories.
      c. Round aluminum ductwork, fittings and accessories.
      d. Round Type 304L stainless steel ductwork, fittings and accessories.
      e. Round flexible ductwork.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Installer Qualifications:
   1. Engage a single installer regularly engaged in ductwork installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
   2. Engage a single installer for the entire ductwork system with undivided responsibility for performance and other requirements.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Local and State Building Codes and Ordinances.
      a. Phoenix Building Code.
      b. Phoenix Mechanical Code.
   2. Underwriters Laboratories, Incorporated (UL).
   3. National Fire Protection Association (NFPA).
   4. American National Standards Institute (ANSI).
   5. Permits: Obtain and pay for all required permits, fees and inspections.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
   2. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
      a. HVAC Duct Construction Standards.
      b. Round Industrial Duct Construction Standards.
      c. Rectangular Industrial Duct Construction Standards.
      d. Fire Damper Guide for Air Handling Systems.
      e. Low Pressure Duct Construction Standards.
   3. American Conference of Governmental Industrial Hygienists “Industrial Ventilation”.
   4. ASTM A 774, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
   5. ASTM A 778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
   6. NFPA 91, Blowers and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
   7. Phoenix Building Code.

E. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

F. Provide certification that all stainless steel ductwork, accessories and hardware are Type 304L stainless steel.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. 1/4-inch scale duct layouts.
   2. Dimensions.
   3. Details of construction.
   4. Details of installation.
   5. Manufacturer's literature, illustrations, specifications and engineering data.
   6. Ceiling diffusers and registers. Provide schedule of air outlets indicating location and quantity.
   7. Fire Dampers:
      a. Closing mechanisms.
      b. Fusible link operating temperature.
      c. Installation details.
      d. Access Doors (UL Listed).
   8. Access doors.
   9. Flexible connections.
   10. Duct sealants.
   11. Deviations from Contract Documents.
   12. Other technical data related to the specified material and equipment as requested by ENGINEER.

B. Test Reports: Submit the following test reports for approval where required.

1. UL Label, Fire Dampers.
2. Damper leakage tests from an AMCA approved testing laboratory.

C. Manufacturer's certified literature indicating compliance with proposed pressure and vacuum classification.

D. Other calculations, dimensions or materials related to the specified product as requested by ENGINEER.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store equipment and materials so as to keep free from moisture, damage, and deterioration.

B. Manufacturer shall protect all flange faces and the more fragile appurtenances of the sub-assemblies, with padding between pieces in order to prevent one piece from impacting with another, and by crating or other means for shipment.

C. Duct sub-assemblies shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and affect the service life of the duct or equipment.

D. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.

E. Ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any ductwork during transportation.

1.5 GENERAL REQUIREMENTS

A. The Drawings show general arrangement and extent of Work to be done, but the exact location and arrangement of all parts shall be determined as the Work progresses, to conform in the best possible manner with its surroundings. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions. Piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc. shall be located to clear such obstructions. Connections shown to the various units are intended as an indication only. The actual connections shall be made and to best suit each particular case, provide for expansion, circulation and minimize the amount of space required.

B. Drawings do not show all offsets, fittings, accessories and details which may be required. Field survey all conditions which may affect the installation of the Work, and shall arrange the Work accordingly. Provide all required items to complete the systems to the extent required by the Contract Documents.

C. If ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.

PART 2 - PRODUCTS

2.1 METALLIC RECTANGULAR DUCTWORK

A. Type:
   1. Aluminum (Alloy 3003 - H-14).
      a. All accessories and hardware shall be aluminum, unless otherwise noted.
      b. All fasteners shall be Type 304L stainless steel, unless otherwise noted.
   2. Type 304L stainless steel.
      a. All accessories, hardware, and fasteners for stainless ductwork shall be Type 304L stainless steel, unless otherwise noted.
      b. Provide Type 304L stainless steel where ductwork is specified to be welded.

B. Construction: Conform to the latest edition of SMACNA (Sheet Metal and Air Conditioning Contractor's National Association, Inc.) Standards.
   1. All sheet metal construction shall conform to a minimum pressure classification of 2-inches of water gauge (positive and negative pressure), unless otherwise shown on the Drawings or specified, and shall be in accordance with the construction details and installation details in the latest edition of the SMACNA HVAC Duct Construction Standards. This standard is hereinafter referred to as HVAC DS.
   2. Duct construction alternatives (duct gage in relation to reinforcement spacing) selected by CONTRACTOR from HVAC DS tables shall be identified by duct system and shall be submitted in schedule form to the ENGINEER prior to beginning installation of ductwork. Construct ductwork to meet the requirements of the HVAC DS tables in conjunction with the minimum thickness schedule below.
   3. Longitudinal seams shall be Pittsburgh type with permanently elasticmatic sealant applied continuously within the seam.
   4. Type 304L stainless steel ductwork minimum thicknesses:

Duct Dimension (maximum side):	**Thickness**:
Under 12-inches	0.028-inch (No. 24 B&S Gage)
Between 12 and 30-inches	0.034-inch (No. 22 B&S Gage)
Between 31 and 36-inches	0.040-inch (No. 20 B&S Gage)
Between 37 and 48-inches	0.052-inch (No. 18 B&S Gage)
Above 48-inches	0.064-inch (No. 16 B&S Gage)

   5. Aluminum ductwork minimum thicknesses:

Duct Dimension (maximum side):	**Thickness**:

Under 12-inches	0.040-inch (No. 18 B&S Gage)
Between 12 and 30-inches	0.050-inch (No. 16 B&S Gage)
Between 31 and 54-inches	0.064-inch (No. 14 B&S Gage)
Between 55 and 84-inches	0.071-inch (No. 13 B&S Gage)
Above 84-inches	0.090-inch (No. 11 B&S Gage)

6. Ductwork shall be connected by a mechanical joining system manufactured by Ductmate Industries, Inc., or equal, except where otherwise noted. Manufacturers' installation instructions will be followed, except where otherwise noted.
    a. Rectangular Ductwork: SMACNA T-24 flange type connectors formed from the duct edge will NOT be allowed. All connectors shall meet or exceed the functional criteria outlined in SMACNA.
        1) Aluminum Ductwork Connectors:
            a) Angle: 0.04-inch thick Type 3003H14 aluminum.
            b) Corner: 0.10-inch thick Type 5052H34 aluminum.
            c) Cleat: 0.07-inch thick PVC.
            d) Gasket: Butyl.
        2) Type 304L Stainless Steel Ductwork Connectors:
            a) Angle: 20 GA. Type 304L stainless steel.
            b) Corner: 16 GA. Type 304L stainless steel.
            c) Cleat: 20 GA. Type 304L stainless steel.
            d) Gasket: Butyl.
7. Stiffener angles shall be constructed of the same material as the duct or transverse connector.
8. Turning Vanes:
    a. Reference: SMACNA.
    b. Construction: Same material as ductwork.
    c. Vanes: Double thickness.
9. Splitter Dampers:
    a. Reference: SMACNA Standards.
    b. Material: Same material as ductwork.
10. Transitions and Offsets:
    a. Reference: SMACNA Standards.
    b. Material: Same material as ductwork.
11. Branch Take-Offs:
    a. Reference: SMACNA Standards.
    b. Material: Same material as ductwork.
    c. 45 degrees, NO straight taps, unless specifically shown on the Drawings.
12. Elbows:
    a. Reference: SMACNA Standards.
    b. Material: Same material as ductwork.
    c. Elbows shall be the radius type with R=1.5, unless specifically shown otherwise on the Drawings.
    d. Where space limitations prevent the use of a radius elbow provide a square throat elbow with turning vanes.

C. Seal Class:
   1. Class B.

D. Leakage:
   1. Not to exceed five percent.

E. Flexible duct or duct constructed of fiberglass duct board shall not be permitted on the job, except where specifically shown on the Drawings.

2.2 METALLIC ROUND DUCTWORK

A. Type:
   1. Aluminum (Alloy 3003 - H-14).
      a. All accessories and hardware shall be aluminum, unless otherwise noted.
      b. All fasteners shall be Type 304L stainless steel, unless otherwise noted.
   2. Type 304L stainless steel.
      a. All accessories, hardware, and fasteners for stainless ductwork shall be Type 304L stainless steel, unless otherwise noted.
      b. Provide Type 304L stainless steel where ductwork is specified to be welded.

B. General: Conform to the latest edition of SMACNA (Sheet Metal and Air Conditioning Contractor's National Association, Inc.) Standards.
   1. All sheet metal construction shall conform to a minimum pressure classification of 2-inches of water gauge (positive and negative pressure), unless otherwise shown on the Drawings or specified, and shall be in accordance with the construction details and installation details in the latest edition of the SMACNA HVAC Duct Construction Standards. This standard is hereinafter referred to as HVAC DS.
   2. Duct construction alternatives (duct gage in relation to reinforcement spacing) selected by CONTRACTOR from HVAC DS tables shall be identified by duct system and shall be submitted in schedule form to the ENGINEER prior to beginning installation of ductwork. Construct ductwork to meet the requirements of the HVAC DS tables in conjunction with the mini-mum thickness schedule below.
   3. Ductwork shall be manufactured by United McGill Corporation Series UNI-SEAL or equal.
   4. Ductwork fittings shall be manufactured by United McGill Corporation Series LOLOSS or equal.
   5. Round, single wall, spiral lock seam ductwork.
   6. Type 304L Stainless Steel Ductwork Minimum Thicknesses:

Duct Diameter	**Minimum Thickness**:
Under 13-inches	26 Gage
14 to 19-inches	24 Gage
20 to 24-inches	22 Gage
25 to 36-inches	20 Gage
37 to 48-inches	18 Gage

7. Aluminum Ductwork Minimum Thicknesses:

Duct Diameter	**Minimum Thickness**:
Under 26-inches	0.040-inch
27 to 36-inches	0.050-inch
37 to 50-inches	0.063-inch

8. Ductwork shall be provided in continuous unjoined lengths wherever possible, except when interrupted by fittings and dampers.
9. Fittings: Elbows shall be die-stamped with a bend radius of 1.5 times the elbow diameter. Converging flow fittings shall be constructed with a radiused entrance to all branch taps and with no excess material projecting from the body into the branch tap entrance. Conform to the following requirements:
   a. All branch entrances shall be by means of factory fabricated fittings or factory fabricated duct tap assemblies.
10. Connections: Ductwork and fittings shall be connected using flanged joints in accordance with the manufacturer's installation procedures and duct sealant recommendations.

C. Seal Class: B

D. Leakage: Not to exceed five percent.

2.3 METALLIC DUCT ACCESSORIES

A. Hangers:
   1. All ductwork shall be supported from trapeze type hangers. Hanger rods shall be minimum 3/8-inch for all ducts with half perimeter up to 72-inches, and 1/2-inch diameter for all ducts with half perimeter larger than 72-inches. A pair of rods shall be provided at each duct support point. Maximum hanger spacing shall be eight feet for ducts with half perimeter up to 72-inches and six feet for ducts with half perimeter larger than 72-inches.
   2. Provide structural steel supports as required to mount hangers from building.
   3. All hangers, rods, supports, bolts, nuts, washers, inserts, supports, and appurtenances located in corrosive areas shall be Type 316 stainless steel and those located in non-corrosive areas shall be galvanized steel.
   4. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.

B. Volume Dampers (Rectangular Ductwork):
   1. Aluminum Ductwork:
      a. Reference: AMCA licensed.
      b. Product and Manufacturer: Provide one of the following:
         1) Swartwout, Phillips Industries

2) Ruskin Manufacturing Company
3) Or equal.

c. Material: Anodized Aluminum.
d. Frame: 0.125-inch thick flanged frame.
e. Blades:
1) Opposed blades.
2) EPDM edge seals with inflatable pocket.
3) Airfoil shape.
f. Linkage: Concealed in frame outside the air stream.
g. Axles: Aluminum hex.
h. Bearings: Molded synthetic.
i. Jamb Seals: Flexible aluminum compressible type.
j. Performance:
1) Damper Leakage: Not more than 6.2 cfm per square foot at 4-inch W.G. for 48-inch by 48-inch section.
2) Certification: Manufacturer shall provide certified test data.

2. Stainless Steel Ductwork:
a. Reference: AMCA licensed.
b. Product and Manufacturer: Provide one of the following:
1) Swartwout, Phillips Industries
2) Ruskin Manufacturing Company
3) Or equal.
c. Material: Type 316 stainless steel.
d. Frame: 14 gauge flanged frame.
e. Blades:
1) Opposed blades.
2) EPDM edge seals with inflatable pocket.
3) Airfoil shape.
f. Linkage: Concealed in frame outside the air stream.
g. Axles: Type 316 stainless steel.
h. Bearings: Outboard bearings with shaft seal.
i. Jamb Seals: Flexible Type 316 stainless steel compressible type.
j. Performance:
1) Damper Leakage: Not more than 6.2 cfm per square foot at 4-inch W.G. for 48-inch by 48-inch section.
2) Certification: Manufacturer shall provide certified test data.

C. Volume Dampers (Round Ductwork):
1. Reference: AMCA licensed.
2. Product and Manufacturer: Provide one of the following:
a. Swartwout, Phillips Industries
b. Or equal.
3. Material: Same as ductwork.
4. Frame:
a. 0.141-inch thick flanged frame up to 12-inch round damper.
b. 0.250-inch thick flanged frame over 12-inch round damper.
5. Blades:
a. 0.250-inch thick opposed blades.
b. Teflon blade seals.

6. Axles:
   a. 0.75-inch diameter up to 24-inch round damper.
   b. 1-inch diameter over 24-inch round damper.
7. Bearings: Relubricatable ball bearings bolted to frame.
8. Performance:
   a. Damper Leakage: Not more than 28 cfm at 14-inches maximum system pressure.
   b. System Pressure: 13-inches w.g.
   c. Certification: Manufacturer shall provide certified test data.
9. Provide outside handle, quadrant and approved position indicator with locking device.

D. Combination Fire and Smoke Dampers (FSD):
1. Type: Dynamic combination fire and smoke damper.
2. Frame: 16 gauge.
3. Blades:
   a. Airfoil shape.
   b. Double skin construction equivalent to 14 gauge construction.
   c. Opposed blade.
   d. Seals:
      1) Silicone edge type for smoke seal to 450°F.
      2) Galvanized steel for flame seal to 1900°F.
4. Construction:
   a. Galvanized steel (for galvanized ductwork)
   b. Type 316 stainless steel (for aluminum and stainless steel ductwork)
5. Control:
   a. Electrically actuated damper under the following conditions:
      1) Smoke is detected.
      2) Temperatures in excess of 165°F is detected.
      3) Interruption of Power.
      4) Automatic remote reset after power is restored.
   b. Damper shall be provided with controls to allow remote reset and damper position indication through building ATC system. Refer to Section 23 09 33.11, Automatic Temperature Controls.
6. Reference: NFPA 90A, SMACNA, UL 555 and Phoenix Building Code.
7. Label:
   a. All fire dampers shall have UL Label attached.
   b. Label shall have a fire rating of minimum 1-1/2 hours for walls rated at two hours and three hours for walls rated above three hours fire rating.
8. Provide firestopping at walls, floors, and ceilings where dampers are installed.
9. Provide a duct access door at each damper.
10. Installation shall conform to Manufacturer's installation recommendations required to meet UL requirements.
11. Product and Manufacturer: Provide one of the following.
    a. Ruskin
    b. Or equal.

E. Access Doors:
1. Rectangular Ductwork:

a. Reference: SMACNA Standards.
b. Type: Gasketed cam lock covers.
c. Materials: Same as duct.
d. Unless otherwise specified access doors shall be:
   1) 12 by X-2 -inches for ducts X-inches and smaller less then 14-inches.
   2) 24 by 12-inches for ducts between 14 and 36-inches.
   3) 24 by 24-inches for ducts between 36 and 60-inches.
   4) Two, 24 by 24-inch doors for ducts larger than 61-inches.
e. Access doors for fire/smoke dampers shall be stenciled "FIRE/SMOKE DAMPER ACCESS" with minimum 1/2-inch high letters.
f. Provide access doors for all smoke detectors and other duct mounted devices where required to be accessible.

2. Round Ductwork:
   a. Reference: SMACNA Standards.
   b. Type: Industrial oval access door with locking hand wheels.
   c. Materials: Same as duct.
   d. Oval access door sizes:

Duct Diameter	**Nominal Opening**:
8 to 18-inches	10 by 6-inches
19 to 48-inches	16 by 12-inches
49 to 72-inches	24 by 18-inches

F. Flexible Connections:
   1. Reference: SMACNA.
   2. Fabric:
      a. 1/16-inch thick minimum reinforced Hypalon or EPDM sheeting.
      b. UV resistant for outdoor use.

G. Miscellaneous Duct Fittings:
   1. Reference: SMACNA Standards.
   2. Material: Same material as ductwork.

H. Sleeves:
   1. Where aluminum ductwork or stainless steel ductwork passes through masonry walls, partitions or floors provide 16 gauge Type 316 stainless steel sleeve.
   2. Calk airtight with fire resistant sealant between sleeve and ductwork.

I. Duct Gasketing:
   1. Gasketing material shall be butyl.

J. Hardware and fasteners:
   1. All hardware and fasteners for aluminum ductwork shall be aluminum, unless otherwise noted.
   2. All hardware and fasteners for stainless steel ductwork shall be Type 304L stainless steel, unless otherwise noted.

K. Duct Liner:
   1. 2-inch thick, 3-pound density. Minimum .70 NRC, minimum 0.24K at mean temperature of 75°F. NFPA-90A approved black coating on one side.
   2. U. L. Ratings:
      a. Flame Spread Max: 25.
      b. Fuel Contribution: 50.
      c. Smoke Developed: 50.
   3. Product and Manufacturer: Provide one of the following:
      a. Manswille, "Microlite".
      b. PPG, “Textrafine”.
      c. Gustin-Bacon, "Ultralite".
      d. Certainteed, "ToughGuard".
      e. Or equal.

2.4 REGISTERS AND DIFFUSERS

A. Supply Registers – WS1:
   1. Extra heavy extruded aluminum construction.
   2. Airfoil blade, double deflection.
   3. Clear anodized finish with acid resistant coating.
   4. Titus, Series 300RS.

B. Product and Manufacturer: Provide one of the following:
   1. Titus.
   2. Tuttle & Bailey.
   3. Or equal.

2.5 DUCTWORK MATERIAL SCHEDULE

A. All ductwork shall be aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All ductwork shall conform accurately to the dimensions shown on the Drawings, the ducts shall be straight and smooth inside with joints neatly finished. Ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.

B. Tape and seal all joints in accordance with SMACNA Standards.

C. Test holes shall be provided as directed by the testing, adjusting and balancing contractor.

D. Fire/Smoke dampers shall be provided and installed where shown on the Drawings and where required by U.L. and authorities having jurisdiction, and shall be approved by Phoenix Building Code and in accordance with the requirements of the NFPA.

E. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration.

F. All ducts at flexible connections with fans shall be supported at free end within 12-inches of flexible connection.

G. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where required.

H. Coordinate all air outlets for compatibility with ceiling system.

I. Install ductliner in roof mounted supply, return and outside air ductwork. Stick clip duct liner to inside walls of ductwork.

3.2 ADJUSTMENT

A. Set volume control devices for approximate positions in preparation for final testing and balancing.

B. Install fusible links in fire dampers and verify that dampers are in open position.

C. Start fan system and check for excessive leaks and vibration and correct.

3.3 CLEANING

A. Remove all loose materials and obstructions from interior of ducts.

B. Remove debris and waste materials resulting from installation.

+ + END OF SECTION + +

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SECTION 23 74 11

PACKAGED ROOFTOP AIR CONDITIONING UNITS - SINGLE ZONE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install packaged rooftop air conditioning units complete and operational with motors, all controls and appurtenances.

B. Products Furnished But Installed Under Other Sections:
   1. Roof mounting frames.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
   1. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
   2. Air-Conditioning and Refrigeration Institute (ARI).
   3. National Fire Protection Agency (NFPA).
   4. Underwriters' Laboratories, Inc. (UL).
   5. Phoenix Building Code.
   6. Phoenix Mechanical Code.
   7. Phoenix Electrical Code.

C. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Air Conditioning and Refrigeration Institute Standards No. 210 and 270.
   2. Underwriters' Laboratories Listed.

D. Source Quality Control: Perform the following shop tests and inspections at the factory:
   1. Coils shall be pneumatically leak tested under water at 200 psig.
   2. Fan wheels and shafts shall be statically and dynamically balanced.
   3. Refrigeration system and controls shall be tested prior to shipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Manufacturer's literature, illustrations, specifications, and engineering data to include the following:
   a. Dimensions and weight.
   b. Details of construction.
   c. Wiring and control diagrams.
   d. Other materials and equipment requested by the ENGINEER.
2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

C. Test Reports: Submit the following test certifications for approval:
1. ARI Label.
2. UL Label.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports, and in accordance with the manufacturer's recommendations for long term storage. Protect steel members and packaged materials from corrosion and deterioration.

D. Delivery of Material:
1. Units shall be equipped with a minimum of four lifting lugs.
2. Spacer bars shall be used in lifting units to prevent damage to casing.
3. Manufacturer's recommendations for rigging of units shall be complied with.
4. Units shall be structurally designed to withstand stresses of hoisting.

1.5 JOB CONDITIONS

A. Environmental Conditions:
1. Ambient Air: 30°F to 120°F
2. Relative Humidity: 10 to 90 percent range
3. Elevation: 1,000 feet above mean sea level.

B. Protection:

1. Roof openings and penetrations shall be capped to prevent rain from entering building prior to installation of units.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Ambient Conditions: Capable of operating at rated capacities at 120°F.

B. Units capacity shall be as shown on the Drawings.

2.2 DETAILS OF CONSTRUCTION

A. Type: Horizontal, self-contained, factory piped, wired and assembled roof top air conditioning units.

B. Casing:
   1. Reference: Underwriter's Laboratory rain test requirements.
   2. Construction: Phosphatized, zinc coated steel.
   3. Finish: Factory applied epoxy resin primer and baked enamel finish.
   4. Factory Insulation: Casings and access panels shall be insulated with one-inch thick, one pound density foil faced glass fiber insulation.
   5. Gaskets: All access panels shall be gasketed.
   6. Handles: All access panels shall have quick release latches and handles.

C. Controls:
   1. Refrigeration Controls include:
      a. Condenser fan.
      b. Evaporator fan.
      c. Compressor contactors.
      d. 24 volt transformer.
      e. Safety Controls:
         1) High and low pressure controls.
         2) Winding thermostats.
         3) Compressor overloads.
      f. Cycle Guard: Prevent unit cycling on overloads and allow safety controls to be reset at thermostat.
      g. Refrigerant Circuit Controls: Each refrigerant circuit shall have an independent, and complete set of refrigeration controls.

D. Direct Expansion Cooling:
   1. Compressor:
      a. Type: Hermetically sealed, welded shell with anti-slugging devices and service shut-off valves.
      b. Controller: Suction pressure operated capacity controller.
      c. Capacity Control: Minimum three steps of loading/unloading.
      d. Provide spring-type vibration isolators.
      e. Crankcase heaters.
      f. Safety controls:
         1) Fusible relief device.

2) Current overloads.
3) Motor winding thermostat.

g. Internal spring isolation.

2. Evaporator Coil:
   a. Type: Dual-circuited multi-row coil.
   b. Construction: 3/8-inch O.D. seamless copper tube mechanically bonded to aluminum fuses.
   c. Coil shall be installed with the following accessories:
      1) Expansion valve.
      2) Dryer.
      3) Solenoid valve.
      4) Sight glass with moisture indicator.
      5) Holding charge of R-22.
3. Drain Pan:
   a. Internally sealed.
   b. Insulated.
   c. Threaded drain connection in evaporator section.
4. Condenser Coil:
   a. Type: Dual-circuited multi-row coil.
   b. Construction: 3/8-inch O.D. seamless copper tube mechanically bonded to aluminum fins.
5. Condenser Fans:
   a. Type: Multi-blade upflow propeller type fans.
   b. Statically and dynamically balanced.
   c. Direct drive.
   d. Permanently lubricated motor.
   e. Built-in thermal overload protection.
   f. Motor U.L. listed for outdoor use.

E. Indoor Air Fans:
   1. Type: Belt driven, forward curved, centrifugal type.
   2. Drive: V-belt drive with adjustable motor sheaves.
   3. Motor:
      a. Permanently lubricated fan and motor bearings.
      b. Thermal overload protection.
      c. Non-overloading at any point on the fan curve.
   4. Fan and motor isolated from unit with rubber motor mounts.

F. Air Filters:
   1. Type: Continuous filament, glass fiber, 2-inch thick, viscosine coated removable media with filter cell.
   2. Efficiency: 78 percent AFI weight test method.
   3. Use standard size filters.
   4. Provide air filter resistance pressure switch to operate filter service light on remote status panel.
   5. Frame: Factory installed filter frame for 2-inch thick filters.

G. Central Control Panel: Provide the following accessories:
   1. Thermostat sub-base with the following switches:
      a. Fan Switch: Two positions, On and Auto.

b. System Switch: Four positions, Heat, Off, Cool and Auto.

2. Three indicating lights and colors as follows:
   a. Power on - green.
   b. Dirty filters - amber.
   c. Rest relay - red.
3. Thermostat: Separate heating and cooling thermostat assembly to automatically utilize outdoor air for cooling.

H. Accessories:
1. Roof Mounting Frame:
   a. Construction: 12 gage zinc coated steel.
   b. Shall match perfectly with base of unit.
   c. Factory applied weatherproofing seal.
2. Economizer Control Mode:
   a. Type: Enthalpy controlled economizer cycle with the following:
      1) Humidistat.
      2) Outdoor air thermostat.
      3) Damper and spring return operator.
      4) Pressure relief damper.
      5) Mixed air thermostat.
      6) Controller.
      7) Ventilation control knob to control minimum position of outdoor air dampers.
3. Night setback thermostat with seven-day timeclock.

I. Product and Manufacturer: Provide one of the following:
1. Trane Company
2. Carrier Corporation
3. Or equal.

2.3 CONTROLS

A. Automatic Temperature Controls:
1. Electrical/Electronic type.
2. Field installation limited to the following:
   a. Night setback thermostat.
   b. Timeclock.
   c. Central control panel.
   d. Freezestat and firestat.
3. Mechanical cooling shall be locked out below 55°F and cooling accomplished by utilization of outdoor air.
4. Mixed air control system will modulate return and outside air dampers to provide:
   a. Minimum ventilation at all times.
   b. Up to 100 percent outside air for natural cooling.
   c. Ventilation lockout shall prevent outside air damper from opening until return air reaches preset level.
   d. Freezestat shall stop unit if heating coil leaving air temperature falls below 40°F.
   e. Firestat in return air shall sop unit if return air temperature exceeds 140°F.

B. Control Sequence:
   1. General:
      a. Manual position of selector switch shall override the timeclock and put the unit in normal day operation.
   2. Winter-day:
      a. Upon start-up of unit, unit fans shall run continuously.
      b. Normally closed minimum outside air damper shall open.
      c. If return air is below 60°F outside, air damper shall remain closed (warm-up cycle).
      d. After completion of warm-up cycle, mixed air thermostat shall modulate normally open return and normally closed maximum outside air dampers to maintain set temperature.
   3. Winter-night:
      a. With selector in "AUTO" position and timeclock in "NIGHT" cycle unit shall be stopped.
      b. Return air damper shall remain opened and outside air damper shall remain closed.
      c. On a demand for heating from the night thermostat, unit shall start.
      d. Unit shall run until night thermostat is satisfied.
   4. Summer-day:
      a. Fan shall run continuously.
      b. Normally closed minimum outside air damper shall open.
      c. Maximum outside air damper shall remain closed and return air damper shall remain open.
      d. Refrigeration controls shall be energized.
      e. Room thermostat shall modulate outdoor air damper and return air damper or compressor to maintain room conditions. Outdoor air damper shall return to minimum position when outdoor temperature or relative humidity are too high for proper cooling with outdoor air.
      f. The outdoor and relief air dampers shall close when the unit is in the “OFF” position.
   5. Summer-night:
      a. Unit shall remain off.

2.4 TOOLS AND SPARE PARTS

A. Each packaged rooftop air conditioning units shall be furnished with the following spare parts:
   1. Two sets of fin combs, for each fin spacing required.
   2. One spare set of replacement filters for each unit.
   3. One spare set of belts for each V-belt drive.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project. Comply with the requirements of Section 01 78 43, Spare Parts and Maintenance Materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine roof curbs to receive unit for:
   1. Horizontal mounting surface.
   2. Water tightness.
   3. Proper anchorage.
   4. Unevenness, irregularities, and incorrect dimensions that would affect quality and execution of installation.

B. Examine piping, ductwork, insulation and electrical connections within curb prior to installing unit for defects, errors, or omissions which would prevent installation of the unit.

C. Do not proceed with installation of unit until all items found defective upon examination have been corrected as recommended by manufacturer and approved by ENGINEER.

3.2 INSTALLATION

A. Rig unit into place.

B. Make final connections of ductwork, piping and control wiring, as detailed on the Drawings and approved Shop Drawings.

3.3 ADJUSTMENT AND CLEANING

A. Remove all debris, waste materials, and loose foreign matter from interior of unit prior to starting fans.

B. Clean tar, dirt or marks from exterior of unit.

C. Adjust all controls for proper settings.

D. Adjust refrigeration suction and discharge pressures according to manufacturer's recommendations.

3.4 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 1 visits, minimum 4 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the air conditioning units conform to requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

C. Start up units in accordance with manufacturer's start up instructions and in the presence of the manufacturer's representative.

D. Comply with requirements of 23 05 93, Testing, Adjusting and Balancing of HVAC Systems.

+ + END OF SECTION + +

SECTION 26 05 01

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to complete the electrical Work.
   2. Equipment shall be rated and labeled by the manufacturer for the environmental conditions in which it is installed including the power disconnects, control stations, and wiring systems.
   3. Conduits and circuits within electrical distribution or utilization equipment and cabinets shall be identified and labeled as specified and as shown.

B. Coordination:
   1. Review installation procedures, drawings and schedules under other Sections and coordinate with other trades the installation of electrical items that must be installed with or within formwork, walls, partitions, ceilings and panels.
   2. Responsible for the installation of all conduits, inserts, and other items to be embedded in the concrete, or built into walls, partitions, ceilings or panels constructed by other contractors. Provide other contractors with detailed plans or sketches of the location of said conduits and other built-in items as may be required. Stay fully informed of the construction where conduits and other built-in items are to be installed. Install said conduits and other built-in items in such a manner and within such time periods as will not unnecessarily delay the work of the other contractors.
   3. Arc Flash Coordination: Review Electrical Pre-Submittal coordination efforts during the Pre-Construction Conference, section 01 31 19.13 with CONTRACTOR, STUDY FIRM, ARC FLASH FACILITATOR and the ENGINEER.
      a. Agenda items for Pre-Construction Conference shall include:
         1) Submittal review routing protocols.
         2) Discuss procedures to handling equipment found to have an incident energy level that requires above a Level 2 PPE.
         3) Electrical safety label installation, as identified in specification 26 05 73.
         4) Single Line Diagram and Power Panel Schedule Record Documents.

   4. Field acceptance testing: As part of field acceptance testing, the Contractor shall provide a complete and comprehensive third party to test to applicable ANSI/NETA ATS 2024 standards on all new equipment which is being installed by this project including but not limited to the following:
      a. 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
      b. 26 05 19.11 - Instrumentation Cables
      c. 26 05 26 - Grounding Systems
      d. 26 05 73 - Power System Studies
      e. 26 09 13 - Power Monitoring System

f. 26 21 00 - Service Entrance Sections
g. 26 24 10 - Low Voltage Distribution Switchboards
h. 26 23 10 - Low Voltage Drawout Switchgears
i. 26 24 16 - Panelboards
j. 26 32 13.10 - 480 Volt Standby Power Generator Systems
k. 26 36 23 - Automatic Transfer Switches

C. General:
1. Interpretation of Drawings:
a. Dimensions shown on the Drawings that are related to equipment are based on the equipment of one manufacturer. Confirm the dimensions of the equipment furnished to the space allocated for that equipment.
b. The Drawings show the principal elements of the electrical Work. They are not intended as detailed working drawings for the electrical Work, but as a complement to the Specifications to clarify the principal features of the electrical systems.
c. It is the intent of the Drawings and Specifications that all equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
d. It also is the intent of the Contract Documents that similar products are provided by the same manufacturer for uniformity on the Project.

D. Temporary Power and Lighting:
1. Refer to Section 01 51 13, Temporary Electricity, for temporary power during construction.
2. Refer to Section 01 51 26, Temporary Lighting, for temporary lighting during construction.
3. If utilizing existing facility power, provide updated panel schedules and/or load summaries to the ENGINEER and OWNER identifying the recommended power sources and circuits for temporary services. ENGINEER and OWNER must provide approval prior to connecting to the services.

E. Utilities:
1. Furnish and install empty conduits and ground for telephone service per utility shop drawings. Plywood backboards and punch-blocks shall be furnished and installed for telephone service, as required for contractor’s job-site trailers. Coordinate with City of Phoenix, Information Technology Services (ITS) Department and Telephone Utility. Plywood backboards shall be painted with approved fire retardant paint. Coordinate with City of Phoenix ITS project requirements and apply for service. Submit all necessary documents and fees required to Telephone Utility.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Permits: Obtain all permits and pay fees required to commence Work and, upon completion of the Work, obtain and deliver to the ENGINEER a Certificate of Inspection and Approval from the authority having jurisdiction.
2. Codes: Material and equipment shall be installed in accordance with the current standards and recommendations of the National Electrical Code, the National Electrical Safety Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
3. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriters' Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.
4. Utilities:
    a. Salt River Project (SRP) Power Company: Work in connection with the electric service and utility metering shall be done in strict conformance with the requirements of SRP.
    b. COX Telephone Company: Work in connection with the telephone lines for the telephone service shall be done in strict conformance with the requirements of the Telephone Company. Telephone system within the Plant is a private system and shall be coordinated with the City of Phoenix, Information Technology Department.
    c. City of Phoenix, Information Technology Department.

B. Reference Standards: Electrical material and equipment shall conform in all respects to the latest approved standards of the following:
1. National Electrical Manufacturers Association (NEMA).
2. The American National Standards Institute (ANSI).
3. The Institute of Electrical and Electronic Engineers (IEEE).
4. Insulated Cable Engineers Association (ICEA).
5. National Electrical Code (NEC) current adoption.
6. National Electrical Safety Code (NESC).
7. American Society for Testing and Materials International (ASTM).
8. The Instrumentation, Systems and Automation Society (ISA).
9. National Fire Protection Agency (NFPA).
10. Underwriter's Laboratories, Inc. (UL).
11. Occupational Safety and Health Administration (OSHA).

C. Wiring Coordinator:
1. Retain the services of a Wiring Coordinator who shall prepare complete point-to-point interconnection wiring termination sheets. The sheets shall identify all external interconnecting wiring associated with all new and modified existing equipment.
    a. Qualifications: Coordinator shall have experience in the development of the point-to-point interconnection wiring termination sheets and shall have served in a similar role on a project of similar size and complexity.
        1) Present qualifications and approach for the project at Pre-Construction Conference specified under Section 01 31 19.13, Pre-Construction Meetings.
        2) Prepare the items listed below for presentation at the Pre-submittal Meeting. Submit to ENGINEER three weeks prior to date of meeting.
            a) List of projects where the Wiring Coordinator developed point-to-point wiring termination sheets.

b) Samples of diagrams that were developed for the listed projects.
c) Example wiring diagram proposed for the Work with a preliminary list of drawings to be produced.
d) Plan of how information will be obtained and documented.

b. Responsibilities:
1) Develop point-to-point interconnection wiring termination sheets for performance of the Work and to document terminations.
2) Use information obtained from approved Shop Drawings, Record Drawings and field inspections as required to complete the sheets.
3) Attend Pre-submittal Meeting and periodic coordination and progress meetings specified in Section 40 61 13, Process Control System - General Requirements.
4) Conduct point-to-point wiring checks to determine wires and terminations are per the point-to-point interconnection wiring termination sheets. CONTRACTOR to sign-off on the sheets to document the checks were performed. After confirmation by the CONTRACTOR, submit the signed sheets to the OWNER/ENGINEER.
a) Point-to-Point Interconnection Wiring Termination Sheets: Include the following:
i. External wiring for each piece of equipment, panel, instrument and other devices and conduit wiring to control stations, lighting panels and motor controllers.
ii. Numbered terminal block identification for each wire termination.
iii. Identification of the assigned wire numbers for all interconnections.
iv. Identification of all conduit wiring by the conduit tag in which the wire is installed.
v. Terminal and pull boxes through which wiring is routed.
vi. Identification of all equipment and the Shop Drawing transmittal numbers for equipment from which the wiring requirements and termination information was obtained.

1.3 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures and Section 01 33 23.10, Shop Drawing Procedures.

B. Shop Drawings shall include the following information to the extent applicable to the particular item:
1. Manufacturer’s name and product designation or catalog number, including environmental rating such as “Rated for Outdoor Use” or “Rated for Hazardous Location”.
2. Electrical ratings.
3. Conformance to applicable standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEC, NEMA, NFPA, OSHA, UL, or other organizations.
4. Dimensioned plan, section, elevations and panel layouts showing means for mounting, conduit connection, and grounding.
5. Materials and finish specification, including paints.
6. List of components including manufacturer’s names and catalog numbers.

7. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.

1.4 PROJECT CLOSEOUT

A. Operation and Maintenance Data: Submit complete manuals including:
   1. Copies of all Record Drawings and Wiring Diagrams, test reports, Power System Study, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

B. Record Drawings:
   1. Furnish four (4) copies of Record Drawings in accordance with the requirements of Section 01 78 39, Project Record Documents, including:
      a. System Record Drawings: Include the following:
         1) One line wiring diagram of the distribution system.
         2) Accurate and detailed in place conduit and cable layouts with schedule of conduit sizes and number and size of conductors.
         3) Layouts of the power and lighting arrangements and the grounding system.
         4) Control schematic diagrams, with terminal numbers and all control devices identified, for all equipment.
         5) Point-to-Point Interconnection Wiring Termination Sheets
   2. The Record Drawings shall reflect final equipment and field installation information.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Instruct the manufacturers and vendors as to the maximum shipping sizes of equipment that can be accommodated at the site.

B. Storage of Materials: Refer to and comply with the requirements of Section 01 66 00, Product Storage and Handling Requirements.

C. Handling of Materials: Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements.

1.6 JOB CONDITIONS

A. Existing Conditions:
   1. Examine the site and existing facilities in order to compare them with the Contract Documents with respect to the conditions of the premises, location of and connection to existing facilities and any obstructions which may be encountered.
   2. Perform the Work with due regard to safety and in a manner that will not interfere with the existing equipment or in any way cause interruption of any of the functions of the plant.
   3. Work shall be carried out with a minimum amount of disruption to the operation of the existing plant and with prior approval of OWNER. Submit for approval by OWNER, a detailed written procedure for work which affects operation of the

existing plant, a detailed procedure for modifying any existing electrical equipment, including appropriate Personal Protective Equipment (PPE) required if equipment must remain energized while conducting work, anticipated time required to complete the Work, and the required shutdown time, if any.

4. Where the Work of CONTRACTOR ties in with existing installations, take prior precautions and safeguards in connecting the Work with the existing operating circuits so as to prevent any interruption to the existing operating circuits. The tying in of Work, installed under this Contract, with the existing circuits shall be performed only in the presence of OWNER. Advance notice will be required before any equipment is removed from service. Notify OWNER, in writing, of his intention to do such work, providing full details.

B. Demolition:
   1. The demolition of electrical power distribution equipment, instrumentation/ control equipment, conduit, wire and appurtenances shall be in accordance with Section 02 41 00, Demolitions.

1.7 CONTROL CABINETS AND PANELS

A. All outdoor panels:
   1. With electronics and temperature sensitive instruments, shall be provided with sunshade structures. Sunshade structures shall be constructed as specified and as shown on drawings.
   2. Shall be Free-Stand Enclosures

B. All control cabinet and panel materials shall meet the area classifications as stated is Section 1.9, unless otherwise specified or noted on the Drawings. Provide the following types of enclosures:
   1. NEMA 3R, 4 or 12
   2. Corrosive Locations, NEMA 4X
   3. Hazardous Locations, NEMA 7

C. Provide the following enclosure features:
   1. NEMA 3R, 4 or 12 Enclosures:
      a. Fabricate enclosures using minimum 14 gage steel for wall or frame mounted enclosures and minimum 12 gage for free standing enclosures. Keep steel free of pitting and surface blemishes.
      b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
      c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
      d. Provide control panel with flatness within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Verify flatness by using a 72-inch long straight edge. Limit out-of-flatness to gradual and in one direction only with no obvious depressions or wavy sections.
      e. Use pan type construction for doors. Door widths are not to exceed 36-inches.
      f. Mount doors with heavy duty hinge(s) with stainless steel hinge pins.
      g. Provide handle-operated, oil-tight, key-lockable three point stainless steel latching system with rollers on latch-rods for easy door closing.
      h. Product and Manufacturer: Provide one of the following:

1) Hoffman
2) Hammond

i. Painting:
1) Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Apply zinc phosphate for corrosion protection.
2) Apply one coat of primer interior and exterior surfaces immediately after corrosion protection has been applied.
3) Coat exterior surfaces with primer surface applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
4) Paint all exterior surfaces minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.
5) Provide compatible primer and finish paint with a low VOC, high solids polyurethane enamel. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.
6) Product and Manufacturer:
a) Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin Williams, Inc
b) Or equal.

2. NEMA 4X Enclosures:
a. Provide enclosures with Type 316 stainless steel construction. Wall or frame mounted enclosures fabricate using a minimum 14 gage steel. Free standing enclosures fabricate using a minimum 12 gage steel. Enclosures smaller than 14”x 12”x 6” fabricate using a minimum of 16 gage steel. Keep steel free of pitting and surface blemishes. Provide all surfaces with a smooth brushed finish.
b. Provide stainless steel fast-operating clamp assemblies on three sides of each door.
c. Rolled lip around three sides of door and along top of enclosure opening.
d. Provide a hasp and staple for padlocking.
e. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad for free-standing panel.
f. Provide 5/16-inch diameter copper ground studs for the ground connection points for all panel equipment and panel doors.
g. Product and Manufacturer: Provide one of the following:
1) Hoffman
2) Hammond

3. NEMA 7 Enclosures;
a. House monitoring and measuring devices located in hazardous environments in explosion-proof control enclosures.
b. Enclosures rated for use in NEC Class 1, Groups C&D or Class II, Groups E, F & G applications and comply with UL and CSA standards.
c. Required Features:
1) Light weight and corrosion resistant copper-free aluminum

2) Integral, cast-on mounting lugs
3) Left side door hinges
4) Viewing windows sized to suit internally mounted components
5) Stainless steel cover bolts
6) Cad-plated steel mounting pans

d. Product and Manufacturer: Provide one of the following:
1) Adalet
2) Killark
3) Crouse-Hinds
4) Hoffman

1.8 ELECTRICAL EQUIPMENT

A. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, with an ambient outside air temperature range of -10°F to 131°F and an elevation of 1086 feet (MSL).

B. All electrical devices and equipment shall have ratings based on 75°C terminations.

C. Mounting of electrical equipment on handrails is not allowed.

1.9 AREA CLASSIFICATIONS

A. Materials and equipment shall conform to the area classification(s) shown on the Drawings, specified and required. In addition to what is shown on the Drawings, the following areas are also Classified and all work shall be in accordance with the National Electric Code and NFPA 820:
1. Wet well interior is Class-1 Division-1
2. Area within 3 feet of the exterior of the wet well (adjacent and above) is Class-1 Division-2.
3. Area within 3 feet of the wet well's air exhaust (odor control) piping and ducts is Class-1 Division-2.
4. Area within 3 feet of the odor control is Class-1 Division-2.

B. Corrosive Locations: Furnish material and equipment for corrosive locations as needed

C. Hazardous Locations: Furnish material and equipment for hazardous locations as needed.

D. Materials, equipment and incidentals in areas identified as hazardous locations shall meet NEC requirements for the Class and Division designated.

1.10 SCHEMATIC DIAGRAMS

A. Schematic diagrams are provided for CONTRACTOR'S guidance in fulfilling the operational intent of the Contract Documents.

B. Responsibility belongs to CONTRACTOR to meet all safety and electrical codes, and to provide all equipment, appurtenances and specialty items required to provide for complete and operable systems.

C. Review of control schemes submitted by CONTRACTOR does not relieve CONTRACTOR of his contractual responsibility to provide complete and successfully operating systems.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Material: Laminated phenolic, engraved to show 1/2-inch high letters, Arial Font, unless stated else where in the CONTRACT DOCUMENTS for a specific piece of equipment. The letters shall be black with white background or match existing.

B. Border: Minimum 1/8-inch around engraved print with extra length for fastening devices.

C. Fasteners: Secured with #4-40, round-head, stainless steel, self-tapping screws.

2.2 WIRE MARKERS

A. Refer to Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.

2.3 CONDUIT TAGS

A. Refer to Section 26 05 33.13, Conduit for Electrical Systems.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. Provide identification of each electrical item, in addition to the manufacturer's nameplates, to identify the item's function, and the equipment or system which it serves or controls.

B. Identify equipment by means of nameplates. Re-label existing equipment whose designation has been changed. Identify potential arc flash hazard levels on equipment with the label specified in Section 26 05 73 – Power System Studies.

C. Identify pull and terminal boxes with nameplates. Identify each box by a unique number. Numbering system shall reflect the actual designations used in the field and as documented on wiring diagrams.

D. Process/Mechanical/Electrical equipment located outdoors shall be labeled by the manufacturer: "For Outdoor Use".

E. Equipment Voltage Labels:
   1. Voltage labels shall be installed on all equipment that has voltage in the equipment.
   2. Where applicable, install voltage label below the Arc Flash Warning label.

3. If the equipment has access to the backs or side of the gear, apply voltage labels on all access panels.
4. Provide standard 3.5-inch by 5-inch, Black/Red on White rectangular labels to match Figure 2.2.C below.
5. Apply a “Danger High Voltage” label to all medium equipment greater than 600 volts.
6. Product and Manufacture: Provide the following:
   a. BRADY
      1) DANGER 120 VOLTS, Part # 86784
      2) DANGER 208 VOLTS, Part # 86782
      3) DANGER 240 VOLTS, Part # 86785
      4) DANGER 480 VOLTS, Part # 86783
      5) DANGER HIGH VOLTAGE INSIDE, Part # 86861
   b. Or Equal.

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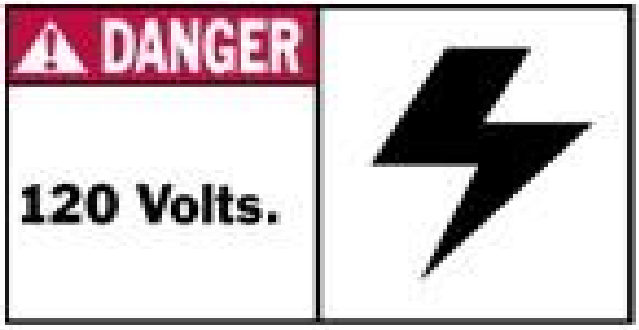

Figure 2.2.C

F. Service Entrance Sections:
   1. Install a Danger Electrical Hazard & Voltage placard on the front side of all Service Entrance Sections.
      a. Placard to be Black/Red on White on aluminum and size to be 7 – inch by 10 – inch to match Figure 2.2.D below.
      b. Install 1.75 inch x 3.5 inch, type printed, high performance polyester appropriate voltage level labels on the placard. Hand written is not allowed
   2. If the Service Entrance Section has access to the backs or side of the gear, apply voltage labels per Paragraph 2.2.C above and Arc Flash Potential Warning labels per Paragraph 2.2.B.2 on all access panels at each main breaker.
   3. Product and Manufacture: Provide the following:
      a. BRADY
         1) DANGER _____ VOLTS, Part # 43141
      b. Or Equal

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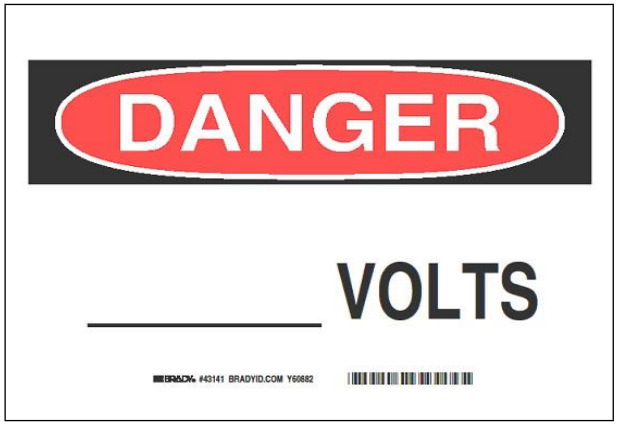


Figure 2.2.D

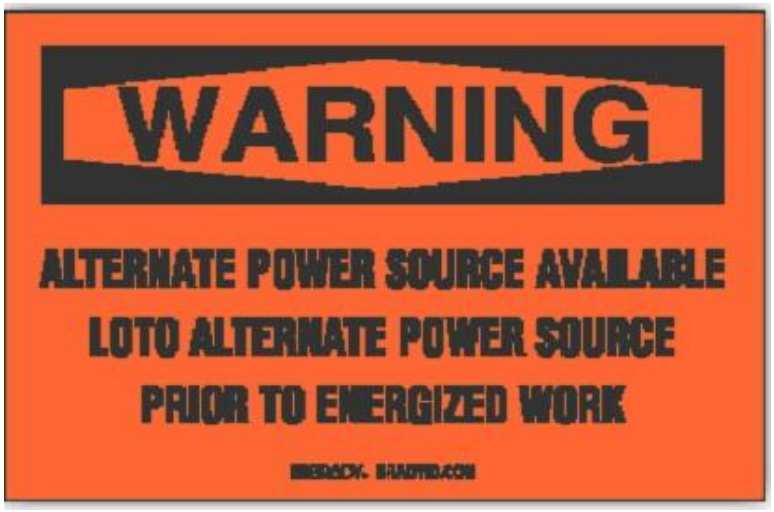
G. Utility Sections:
   1. When the Utility Sections has access to the back, apply a standard 3.5-inch by 5-inch, Black/Red on White rectangular “DANGER” label stating to match Figure 2.2.E below and Arc Flash Potential Warning labels per Paragraph 2.2.B.2.
   2. Product and Manufacture: Provide the following:
      a. BRADY
      b. Or Equal

Figure 2.2.E

H. Additional Sources of Power:
   1. When more than one source of power is located inside the equipment apply standard 3.5-inch by 5-inch, Black/Red on White rectangular “DANGER” label stating to match Figure 2.2.F below.
   2. Product and Manufacture: Provide the following:
      a. BRADY
      b. Or Equal

Figure 2.2.F

I. Generator Power Sources:
   1. There are to be no Arc Flash Potential Labels printed or applied pertaining to any system that has generation power as an alternate source. For these sites apply at the automatic transfer switch a standard 3.5-inch by 5-inch, Black on Orange “WARNING” label stating to match Figure 2.2.G below
   2. Product and Manufacture: Provide the following:
      a. BRADY
      b. Or Equal



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SECTION 26 06 03

UTILITY COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Coordination with the utility companies to provide temporary and permanent electrical and communication services.
   2. Contractor's responsibilities for connecting to utilities and providing utility (electrical and communication) service to the facilities.
   3. Descriptions of utility services required.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. Refer to all Sections of Division 16 (Electrical) for additional requirements not indicated here.

1.3 DEFINITIONS

A. Utility contacts:
   1. Electric utility:
      a. Name: Shannon Emmons
      b. Utility: Salt River Project (SRP).
      c. Address: SRP Phoenix, AZ 85072
      d. Phone number: 602-236-4745.
      e. E-mail: Shannon.emmons@srpnet.com
   2. Telephone utility:
      a. Name: COX Communications.
      b. Utility: Telephone and Cable.
      c. Address: Local.

1.4 SYSTEM DESCRIPTION

A. Temporary Electrical Service For The Construction:
   1. Provide all Work and materials and bear all costs for providing temporary construction electrical service, including but not limited to:
      a. All Work and materials not provided by the electric utility.

b. All permits and fees required by the electric utility.

B. Temporary, Transition, and Permanent Electrical Service:
1. Pre-Bid Coordination: In addition to the minimum requirements indicated on the Contract Drawings, the CONTRACTOR shall contact SRP, and investigate any additional requirements that are necessary for this project. Refer to SRP's ELECTRICAL SERVICE SPECIFICATIONS in order to determine the complete scope of work prior to the Bid.
2. Electrical Service (temporary, transition, and permanent): Construction Phase Coordination: CONTRACTOR shall coordinate all work with SRP. This coordination shall include, but is not limited to, the following:
   a. Utility company's design drawings and specifications
   b. Pre-construction meetings and coordination
   c. Utility demolition work
   d. Utility Manholes
   e. Utility service work
   f. Utility cable and conduit (ductbank) work (primary and secondary)
   g. Utility power pole work
   h. Utility power underground work
   i. Utility transformer work
   j. Utility switch and fuse cabinet work
   k. Utility automatic transfer switch and fuse cabinet work
   l. City inspection of the service entrance section
   m. Phasing of the power between temporary, transition, and permanent
   n. Utility company inspection
   o. Utility energization/de-energization/re-energization work
   p. Any and all work not indicated above.

C. Telephone service:
1. Retain the services of the Project site's Communication company and a cable locating company to locate the existing communication (i.e. telephone) cables.
2. Furnish and install underground conduit for new communication cable. Assume 500 feet for the bidding purposes.
3. Provide all Work and materials and bear all costs for connections to the existing telephone service:
   a. All permits and fees required by the telephone utility.
4. Provide the telephone entrance conduit(s) from the terminal pole to the telephone board in the pump control panel or Communication cabinet, and all other Work and materials required for a complete telephone service.

D. General:
   1. Coordinate and obtain inspections and final installation approval from the serving utilities and other authorities having jurisdiction.

1.5 SUBMITTALS

A. Furnish submittals as specified in Sections 01 33 00 and 26 05 01.

B. Certification:
   1. Submit certification that the intended installation has been coordinated with the utility companies.
   2. Include a narrative description of the utility's requirements and points of connection, names and telephone numbers for contacts at the utilities.

1.6 QUALITY ASSURANCE

A. As specified in Section 26 05 01.

B. Materials and equipment used in performance of Electrical Work shall be listed or labeled by UL, or other equivalent recognized independent testing laboratory, for the class of service intended.

1.7 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 05 01.

1.8 SCHEDULING

A. General:
   1. Before start of Site Work, make arrangements for temporary telephone and electrical service as required.

B. Electrical systems:
   1. Before bidding, the electrical contractor shall contact the utilities to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.
   2. Coordinate Work with Engineer to minimize downtime of existing operating equipment and electrical distribution systems and to preclude unsafe operation:
      a. Notify Owner 28 days before power interruptions.
      b. Coordinate downtime with Owner and local electric utility.
   3. Before commencing Work, coordinate electric service entrance requirements with local electric utility to assure that the installation will be complete as specified in these Contract Documents:

a. Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades.
b. Arrange for utility revenue meter.

4. During the construction of the Project, the existing electrical service must remain fully functional in order to supply uninterrupted electrical power to the facility and its ancillary buildings and structures.

C. Telephone systems:
1. Before commencing Work, coordinate complete telephone service:
a. Verify compliance with telephone utility requirements.
b. Verify exact location of each service point and type of service.

D. Before commencing Site Work, coordinate underground conduit installations with other Work to eliminate conflicts and avoid interferences with other underground systems.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Furnish materials in accordance with the applicable requirements of the utilities and as specified in these Specifications.

B. For electrical utility service, furnish and install the following in accordance with SRP's Electric Service Specifications (this work is not indicated on the drawings):
1) Primary conduits (and all work associated with them)
2) Secondary conduits (and all work associated with them)
3) Concrete pads for transformers, switches, and automatic transfer switches (and all work associated with them)
4) Manholes and handholes (and all work associated with them)
5) All other requirements indicated in SRP's Electric Service Specifications.

C. For telephone and telephone communication lines, furnish and install the following in accordance with Cox Communications requirements (this work is not indicated on the drawings):
1) Conduits (assume 1,000 feet of 2 inch conduit) in accordance with Typical Detail E101.

2.2 EQUIPMENT

A. Furnish equipment in accordance with the applicable requirements of the utilities and as specified in these Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. For electrical services: Perform all installation per utility company's requirements.

B. For communication services: Perform all installation per communication company's requirements.

END OF SECTION

SECTION 26 05 05

TRANSITION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required for demolitions, removal, and disposal Work as well as temporary and new Work (for electrical, instrumentation, and control) for the following:
      a. Transitioning the existing lift station to the new lift station operations
      b. Transition where both the existing lift station and the new lift station are in operation simultaneously
      c. Demolition of the existing lift station
      d. And any sub-transitions required.

1.2 SUBMITTALS

A. Schedule: Submit for approval proposed methods, equipment, operating sequences, and MOPOs for the following:
   1. Transitioning from the existing lift station to the new lift station operations
   2. Work during the transition where both the existing lift station and the new lift station are in operation
   3. Demolition of the existing lift station
   4. And any sub-transitions required.

B. Include coordination for the following:
   1. Disconnection and reconnection of utility power equipment and their circuits
   2. Disconnection and reconnection of power distribution equipment and their circuits
   3. Disconnection and reconnection of control systems and their circuits
   4. Disconnection and reconnection of instruments and their circuits
   5. Disconnection and reconnection of SCADA and communication systems, and their circuits

   Perform all above work such as to ensure no interruption of OWNER'S operations unless shutdowns are specifically granted by OWNER.

C. Notification:
   1. At least twenty-eight (**28**) calendar days prior to commencement of a transition work, notify OWNER and ENGINEER, in writing, of the proposed work, transition, work, and schedule.

PART 2 – PRODUCTS

2.1 TEMPORARY PRIME GENERATOR

A. The Prime Generator shall be sized to run the full existing lift station loads for two (or more) anticipated power outages, each ranging from 7 days to 14 days minimum, or more based on the transition needs.
   1. Furnish and install rental generator (and all its appurtenances) in order to provide a fully independent functioning Prime Generator System.
   2. Furnish and install all cables and connections.
   3. Provide NETA testing for the generator system and its cables.
   4. Provide fuel for the entire operation.

2.2 TEMPORARY STANDBY GENERATOR

A. The Standby Generator shall be sized to run the full existing lift station loads for two (or more) anticipated power outages, each ranging from 7 days to 14 days minimum, or more based on the transition needs.
   1. Furnish and install rental generator (and all its appurtenances) in order to provide a fully independent functioning Prime Generator System.
   2. Furnish and install all cables and connections.
   3. Provide NETA testing for the generator system and its cables.
   4. Provide fuel for the entire operation.

2.3 TEMPORARY AUTOMATIC TRANSFER SWITCH

A. The Standby Generator shall be sized to run the full existing lift station loads for two (or more) anticipated power outages, each ranging from 7 days to 14 days minimum, or more based on the transition needs.
   1. Furnish and install rental ATS (and all its appurtenances) in order to provide a fully independent functioning ATS.
   2. Furnish and install all cables and connections.
   3. Provide NETA testing for the ATS and its cables.

PART 3 - EXECUTION

3.1 TRANSITION

A. Fully man the site during the outages to ensure generator's fully functioning operations during the utility outage. The individual(s) shall be fully capable of operating the generators and ATS and fix operational issues

+ + END OF SECTION + +

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install 600 volt cable.
   2. The types of cable required include the following:
      a. Insulated cable for installation in raceways.
      b. Cable for installation in trays.
      c. Direct burial cable.
      d. Direct burial cable duct.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of Regulatory Agencies below and others having jurisdiction:
   1. Codes: Install cable in accordance with the Phoenix Electrical Code and applicable local codes.
   2. Tests by Independent Regulatory Agencies: Cable shall bear the label of the Underwriters' Laboratories, Inc.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. ASTM B 3, Soft or Annealed Copper Wire.
   2. ASTM B 8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
   3. ICEA S-66-524, Cross-linked-thermosetting- polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   4. National Electrical Code (NEC) current adoption.
   5. City of Phoenix – Amendments to the National Electrical Code.
   6. UL Standard No. 44, Wires and Cables, Rubber-Insulated.
   7. UL Standard No. 83, Wires and Cables, Thermoplastic-Insulated.
   8. IEEE Standard 971.

C. Factory Production Tests:
   1. All wire and cable shall be factory tested in accordance with the requirements of Underwriters' Laboratories.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, specifications, and engineering data for 600 volt insulated cable proposed for use.
   2. Manufacturer's literature for cable markers.

B. Test Records: Submit for review copies of written records of field insulation resistance test results.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulated Cable In Raceways:
   1. Material: Single conductor copper cable conforming to ASTM B 3 and B 8 with flame-retardant, moisture and heat resistant cross-linked polyethylene or thermoplastic insulation rated 90°C in dry locations and 75°C in wet locations and listed by UL as Type XHHW-2. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.
   2. Application: Use Type XHHW-2 for all sizes, unless otherwise indicated.
   3. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120 volt control circuits
   4. Stranding: All 600 volt cable shall be stranded.
   5. Product and Manufacturer: Provide one of the following:
      a. Okonite Company
      b. Encore Wire Corporation
      c. The Southwire Company
      d. Service Wire Company
      e. General Cable

B. Cable for Installation in Trays:
   1. Material: Factory assembled cable, multi-conductor as required by the Drawings, Type XHHW-2 bearing the UL label, Type TC and specifically approved for installation in cable trays and meeting the flame test requirements of IEEE 1202.
   2. For control circuits provide a minimum number of two (2) spare conductors per cable.
   3. Product and Manufacturer: Provide one of the following:
      a. The Southwire Company.
      b. The Okonite Company.
      c. Service Wire

B. Direct Burial Cable:
   1. Single or multiconductor, stranded copper conductors, 60-mils butadiene styrene or ethylene propylene insulation, overall jacket of neoprene or PVC. Rated at 600 volts.
   2. Product and Manufacturer: Provide one of the following:
      a. The Okonite Company.
      b. American Insulated Wire Corporation.

C. Direct Burial Cable Duct:
   1. Material: Multi conductor stranded copper cables; 600 volt cross-linked polyethylene insulated, factory assembled in a coilable, medium density polyethylene duct suitable for direct burial in earth for operation at a maximum conductor temperature of 90°C.
   2. Product and Manufacturer: Provide one of the following:
      a. Cablecon by Integral Corporation.
      b. Tamaqua Duct System by Tamaqua Cable Products Corporation.

D. Cable Connectors, Solderless Type:
   1. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminals. If terminal block is crimp type, then the wire shall be terminated with a crimped ferrule or solder dipped.
   2. Product and Manufacturer: Provide one of the following:
      a. Phoenix Contact – Clipline
      b. Thomas & Betts
      c. Weidmuller
      d. Burndy Hylug
   3. For wire sizes No. 4 AWG and above, use either compression type or bolted type with tinned-plated contact faces.
   4. For wire sizes No. 250 kcmil and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
   5. Properly size connectors to fit fastening device and wire size.

E. Cable Splices:
   1. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by the cable manufacturers, to provide insulation equal to that on the conductors.
   2. For wire sizes No. 10 AWG and smaller, splices may be made up with preinsulated spring connectors.
   3. For wet locations, splices shall be waterproofed. Compression type splices shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with a sealant-filler.
   4. Product and Manufacturer: Provide one of the following:
      a. Compression-Type Splices:
         1) Burndy Hylink.
         2) T&B Color-Keyed Compression Connectors.
      b. Spring Connectors:
         1) Buchanan B-Cap.
         2) T&B Wire Connector.

F. Cable/Wire Markers:
   1. Provide only heat shrinkage type cable/wire identification, which shall be type-written.
   2. Wire number shall include the conduit number and be a consecutive number based on the number of wires in a conduit, starting with number 1; example C18J – 1, where as C18J is the conduit number and 1 is the first wire. If ten wires are in a conduit, the numbering would be C18J-1 through C18J-10. No two wires are to have the same number.
   3. Product and Manufacturer: Provide the following:
      a. By W.H. Brady Company. (Part # PSPT-187 for a single conductor)
      b. Or Approved Equal

PART 2 - EXECUTION

2.1 INSTALLATION

A. Install all cables complete with proper identification and terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within the limits recommended by the wire and cable manufacturer.
   3. Use a dynamometer where mechanical means are used.
   4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to a minimum of six times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Splices:
   1. Where possible, install cable continuous, without splice, from termination to termination.
   2. Where required, splice where shown on the Drawings or as approved by the ENGINEER and also where required for cable installation. All splices below grade, in manholes, handholes and wet locations shall be waterproofed.
   3. Splices are not allowed in conduits.
   4. All splices shall be pre-approved by ENGINEER.

F. Identification:
   1. Each cable and conductor shall be identified in each pull box and manhole with identification markers, which shall include the conduit number and/or cable number. The markers shall be self-laminating vinyl on white background and shall be printed using a Brady "Tagus T300" printer or equal.

G. Phase Identification/Color Coding:
   1. All three phase circuits shall be identified, which shall include the conduit number and phase, at switchgear, motor control centers, manholes (5 KV), cables and panelboards as "PHASE A"," PHASE B", and "PHASE C". All conductors not identified with a tag number shall be identified with a tag indicating the source.
   2. Three phase 480 volt systems shall be color coded as follows:
      a. Phase A - Brown.
      b. Phase B - Orange.
      c. Phase C - Yellow.
      d. Neutral (if applicable) – Gray.
   3. Single phase, 120/240 volt circuits shall be color coded as follows:
      a. Phase A - Black.
      b. Phase B - Red.
      c. Neutral - White.

4. Three phase, 208 volt systems shall be color coded as follows:
   a. Phase A - Black.
   b. Phase B - Red.
   c. Phase C - Blue.
   d. Neutral - White.
5. No. 6 AWG and Smaller: Provide colored conductors.
6. No. 4 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least 2-inches.
7. All field wiring color shall be black unless otherwise noted.

H. Verify mechanical connection by using a calibrated torque wrench on all conductors 4/0AWG and larger. Torque to be witnessed by ENGINEER.

2.2 TESTING

A. Test each electrical circuit after permanent cables are in place to demonstrate that the circuit and connected equipment perform satisfactorily and that they are free from improper grounds and short circuits.

B. Individually test 600 volt cable mechanical connections after installation and before they are put in service with a calibrated torque wrench. Values shall be in accordance with manufacturers' recommendations.

C. Individually test 600 volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service with a Megger whose rating is suitable for the tested circuit. Tests shall meet with the applicable specifications of IPCEA S-66-524 and NEMA WC7-1971. Tests shall be witnessed by the ENGINEER.

D. The insulation resistance for any given conductor shall not be less than the value recommended by the IPCEA or a minimum of one megohm for 600 volt and less service, if not IPCEA listed. Any cable not conforming to the recommended value or which fails when tested under full load conditions shall be replaced with a new cable for the full length.

E. Install in accordance with the National Electrical Code and the City of Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 26 05 19.11

INSTRUMENTATION CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

1. Scope:
2. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install instrumentation, telephone cables and security system fiber cables.
3. The types of cable include the following:
   a. Single Conductor Control Cable
   b. Shielded Cable
   c. Unshielded Cable
   d. Telephone Cable
   e. Intercom and Paging System Cable
   f. Security Cable
   g. TC Rated Cable

1.2 SUBMITTALS

1. Shop Drawings: Submit for approval the following:
2. Manufacturer's technical information for instrumentation cable proposed for use.
3. Manufacturer’s technical information for telephone cable and underground splicing for approval by the City of Phoenix, Information Technology Department.

PART 2 - PRODUCTS

2.1 MATERIALS

A. 120 Volt or less Single Conductor Control Cables see Section 26 05 19.2.1.A
   1.
   2. Single Shielded Pair Cable:
   3. Tinned copper, nineteen strand, PVC insulated conductors, No. 16 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 16 AWG copper drain wire and PVC black or gray outer jacket. Wire conductor colors shall be black (-neg) and red (+pos). 600 Volt Tray Cable (TC) rated.
   4. Product and Manufacturer: Provide one of the following:
      a. Belden Company (No. 9342).
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.

   5. Multipaired Shielded Cable:

6. To be utilized only for wiring between Remote Terminal Units and Intermediate Terminal Panels as shown on drawings.
7. Bare, soft annealed copper, seven strand, tinned copper conductors, PVC insulated conductors, No. 16 AWG minimum, twisted in pairs with aluminum-mylar shield over each pair, tray cable rated, silicone rubber fiberglass fire barrier tape, tinned copper drain wire, pairs shall be individually numbered, aluminum mylar overall shield, PVC outer jacket. Color shall be black and red. Rated for 600 volts. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.
8. For control circuits provide a minimum number of two (2) spare conductors per cable.
9. Product and Manufacturer: Provide one of the following:
    a. Belden, No. 1043B.
    b. Or equal.
10. Telephone Cable:
11. Bare, solid annealed copper, No. 22 AWG twisted pairs with solid polyolefin insulation, color coded to telephone industry standards. Cable core shall be filled with a water proofing compound and wrapped with a non-hygroscopic core tape. Shielding shall be constructed of 0.005-inch solid copper. Cable shall be finished with a black polyethylene jacket. Cable shall contain the number of pairs as shown on the Drawings.
12. Product and Manufacturer: Provide one of the following:
    a. Anixter.
    b. Or equal.

13. Intercom and Paging System Cable:
14. Cable for the connection of the remote staff stations associated with the intercom or paging system shall be single pair shielded audio and data cable insulated for 600 volt, as manufactured by Belden, No. 8719, Mohawk equivalent, or equal.
15. Where paging system cables are shown on the Drawings, two single pairs of the specified cable shall be installed in the indicated conduit, one shall serve as a spare.
16. Product and Manufacturer: Provide one of the following:
    a. Belden, No. 8719.
    b. Mohawk.
    c. Or equal.

17. Cable Terminals:
18. Provide ferule compression fittings or UL listed fork type copper compression terminals with nylon insulation for termination of cable at all terminal blocks.
19. For Panels provided under 40 67 00, see Section 40 67 00 - Control Panels. Field Wire Termination for termination methods, product and manufacturer.
20. Product and Manufacturer: Provide one of the following:
    a. T&B Sta-Kon.
    b. Burndy Insulug.

B. Cable/Wire Markers:
    1. Provide only heat shrinkage type cable/wire identification, which shall be type-written.

2. Wire number shall include the conduit number and be a consecutive number based on the number of wires in a conduit, starting with number 1; example C18J – 1, where as C18J is the conduit number and 1 is the first wire. If ten wires are in a conduit, the numbering would be C18J-1 through C18J-10. No two wires are to have the same number.
3. Product and Manufacturer: Provide the following:
   a. W.H. Brady Company. (Part # PSPT-187 for a single conductor)
   b. W.H. Brady Company. (Part # PSPT-500-1W for a twisted pair shielded cable)
   c. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Separation Requirements:
   1. Instrumentation Cables shall not be installed within the same conduits, raceways or cable trays with cables identified in Sections 26 05 19, 26 05 13.19 and 26 05 13.23.
   2. Telephone Cables are to be routed separately from other cables.
   3. Intercom and Paging System Cables are to be routed separately from other cables.
   4. Fire Detection or Protection System Cables are to be routed separately from other cables.
   5. Security System Cables are to be routed separately from other cables unless noted on the drawings.
   6. Additional separation requirements:
      a. Class 1 Control circuits (limited to 120 V, see NEC Section 725 Parts I & II for Class 1 Circuits) are to be routed separately from other cables. (Lights and starter circuits)
      b. Class 2 Control circuits (limited current and less than 50 V, see NEC Section 725 Parts I & III for Class 2 Circuits) are to be routed separately from other cables. (Analog signal, digital communications, Discrete Inputs and Outputs)
      c. Class 3 Control circuits (limited current and less than 120 V, see NEC Section 725 Parts I & III for Class 3 Circuits) are to be routed separately from other cables. (Discrete Inputs to and Outputs from OPTO 22 modules to or from contacts and interposing relay coils.)
   7. Install all cables complete with proper identification and terminations at both ends. Cable outer installation shall be dressed at the end of the cables with heat shrink tubing prior to terminations. Utilizing electrical tape is not allowed for dressing.
   8. Ground shield of shielded cables at one end only and as recommended by instrument manufacturer. When multiple shielded cables are terminated on a designated analog terminal strip an insulated green with yellow strip wire is used to jumper between the shield terminals and at the end of the terminal strip terminate the shields to the isolated DC ground bar mounted in the panel.
   9. Terminate stranded conductors with pre-insulated crimp type spade or barrel compression fitting terminals properly sized to fit fastening device and wire size.

10. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.
11. Coordinate the installation and termination of the telephone cables with the City of Phoenix, Information Technology Department.
12. Install in conformance with the National Electrical Code and the City of Phoenix Electrical Code.
13. Maintian 12 inches of separation between AC and DC wire and cables.

B. Identification:
1. Each cable and conductor shall be identified in each pull box and manhole with identification markers, which shall include the conduit number and/or cable number. The markers shall be self-laminating vinyl on white background and shall be printed using a Brady "XC Plus" printer or equal.

3.2 TESTING

1. Test all 600 volt wiring in accordance with the requirements of Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.
2.
3. Test shielded instrumentation cable shields with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground. The tests shall be witness by the OWNER and ENGINEER.
4.
5. Connect shielded instrumentation cables to a calibrated 4 to 20 mADC signal transmitter and receiver. Test at 4, 12 and 20 milliamp transmitter settings.
6.
7. Telephone cables shall be tested in accordance with and in the presence of the City of Phoenix, Information Technology Department. A written proposed schedule shall be submitted a minimum of seven days prior to the testing of each telephone cable for inspection coordination.
8.

+ + END OF SECTION + +

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SECTION 26 05 26

GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install complete grounding for the electrical systems, structures and equipment.
   2. Pump cans and buried piping shall be bonded to the ground grid.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) Article 250, Grounding.
   2. Underwriters Laboratories (UL) Standard No. 467, Electrical Grounding and Bonding Equipment.
   3. ANSI-J-STD-607-A, Commercial Building Grounding Earthing and Bonding Requirements for Telecommunications.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for grounding materials proposed for use.
   2. Listing of grounding connector types identifying where they are to be used.
   3. Layouts of each structure ground grid.
   4. Test point construction details.
   5. Ground resistance test procedure.
   6. Results of ground resistance tests at each test point. Provide the test information and results as required on form 26 05 01-N in Specification 01 33 10 – Reference Forms.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bare Ground Cable:
   1. Material: Annealed, bare, stranded copper.
   2. Product and Manufacturer: Provide ground cable of one of the following:
      a. Southwire Corporation.
      b. Service Wire Corporation.
      c. Encore Wire Company.

B. Ground Rods:
   1. Material: Copperclad rigid steel rods, 3/4-inch diameter, ten feet long.

2. Manufacturer: Provide ground rods by one of the following:
   a. ERICO.
   b. A.B. Chance Company.
   c. South Atlantic, L.L.C.
   d. Harger.

C. Grounding Connectors:
1. Material: Pressure connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
2. Product and Manufacturer: Provide grounding connectors of one of the following:
   a. Pressure Connectors:
      1) O.Z./Gedney, Division of General Signal Corporation.
      2) Burndy Corporation.
   b. Welded Connections:
      1) Cadweld by Erico Products, Incorporated.
      2) Therm-O-Weld by Burndy Corporation.

D. Concrete Boxes:
1. Material: High density reinforced concrete box with non-settling shoulders positioned to maintain grade and facilitate back filling with steel checker plate screw down cover.
2. Size:
   a. Outside Locations: 15” x 22” minimum.
   b. Inside Locations: 10” x 17” minimum.
3. Product and Manufacturer: Provide box assembly from one of the following:
   a. Concrete Box:
      1) Christy Concrete Products, Inc. Model #B1017.
      2) Or Equal.
   b. Steel Cover:
      1) Christy Concrete Products, Inc. Model #B61JH labeled “GROUND”.
      2) Or Equal.

PART 3 - EXECUTION

3.1 STRUCTURE GROUND SYSTEM

A. Provide ground grids as shown on the Drawings.

B. Install No. 4/0 AWG bare copper cable. Install the cable around the exterior perimeter of structures, minimum 2 feet-6 inches below grade, unless otherwise shown on the Drawings.

C. Install ground rods where shown on the Drawings. Install additional ground rods, if necessary, to attain a resistance to ground of less than twenty five (25) ohms for each ground grid.

D. For structures with steel columns, install 4/0 AWG ground cable. Install cable from grid to each column around the perimeter of the structure. Connect cable to steel using exothermic welds.

E. Connect grids to a continuous underground water pipe system, when practical.

F. Provide concrete ground test wells for measuring the ground resistance of each separately derived power source, including generators, prior to terminating in equipment. Provide 12" ground conductor slack loop in each well. Route ground conductor from test well to equipment in PVC conduit.

G. Weld all buried connections. Test points connections shall utilize pressure connectors.

3.2 EQUIPMENT GROUNDING

A. Ground all electrical equipment in compliance with the National Electrical Code and the City of Phoenix Electrical Code.

B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where necessary for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.

C. Panel Grounding:
   1. A minimum size of 4/0 AWG bare stranded copper cable shall be installed between the ground grid and the panel enclosure grounding lug. The mounting frame for panels shall be grounded to the ground grid.
   2. A minimum size of 6 AWG insulated green stranded copper cable shall be installed between the ground grid and the isolated DC Ground Bus located on the enclosure sub-panel. This ground shall be installed in all panels that provide an isolated DC Ground Bus.

D. A separate green insulated ground conductor sized per conduit schedule as shown on DRAWINGS or NEC requirements shall be pulled into conduits and connected utilizing grounding conduit bushings.

E. Connect ground cable to piping by welding or brazing. Use copper bonding jumpers on all gasketed joints.

F. Connect ground cable to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not install with hold down bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.

G. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.

H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.

I. Scrape bolted surfaces clean and coat with a conductive oxide- resistant compound.

J. Test all system grounding conductors for continuity of connection and electrical equipment. Provide in the final report a statement on equipment that was tested and document any discrepancies noted during the tests.

3.3 GROUND GRID TESTING

A. The CONTRACTOR shall contract the firm ARCADIS U.S. Inc. ((602) 448-2089) as the Testing Firm to provide testing of the grounding electrode system as shown on DRAWINGS.

1. Performing the following ground single point test:
   a. Conduct test at the testing point(s) locations as shown on the DRAWINGS using a clamp-on ground tester.
      1) Utilize the following test equipment:
         a) Fluke, Model 1625 Kit
   b. Visually inspect the installed ground reference electrode or ground rods. Verify that they are intact and accessible. Measure the ground system at these test points with the clamp-on meter. The results shall be recorded on the Ground Test Point Data Sheet 26 05 01-N as provided in Specification 01 33 10 – Reference Forms.
   c. Proved a Serial Key number for each test point shown on the DRAWINGS. Coordinate with OWNER to determine the Serial Key number. Update the RECORD DRAWINGS with the Serial Key number.
   d. Install metal ground test point tags identified with a Serial Key number at each test point using stainless steel wire and zinc wire clamps. For any test points within equipment, attach test point tag to exterior of equipment with epoxy.
   e. Digitally Photograph clamp-on meter in place during test and include with test data sheets. Digital images shall have the Serial Key identified for reference. Digital images of these test points with the clamp-on tester in place are to provide a visual representation of the proper clamp-on testing placement and method and shall be inserted into the ground test sheet document.

B. The grounding system maximum resistance shall not exceed twenty five (25) ohms under normally dry conditions when measured by the resistance tester.

C. Install grounding test tags for each grounding test. Provide the following for each tag. Install tag with epoxy if unable to utilize wire and clamp.

Item	Description	Part No.	Manufacturer
1	Two Part Non-Sag Epoxy		Hardman
2	Stainless Steel Wire/ 30 ft roll	38091	Brady
3	Zinc Wire Clamps 50/pk	38090	Brady
4	Aluminum Tag - Green	49908	Brady

D. Tests shall be witnessed by the ENGINEER and OWNER.

+ + END OF SECTION + +

SECTION 26 05 33.13

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install conduit and fittings to provide complete, coordinated and grounded raceway systems.
2. Conduit routings for various systems within buildings and other areas may not be shown on the Drawings. Responsibility to establish single line, riser and interconnection diagrams and any other related information shown on the Drawings, belongs to CONTRACTOR. Provide for the proper installation of all conduits for each system. Submit conduit routing and tagging meeting all specifications of Submittals Section 1.3-A and Section 2.1-G below to Engineer/Owner for review and approval prior to construction.
3. The following types and installation methods shall conform to the following:
   a. Polyvinyl Chloride (PVC) Coated Rigid Metal Conduit (NEC Article 344)
      1) Corrosive areas.
      2) For exposed indoor conduit runs.
      3) For exposed conduit runs in all outdoor areas.
      4) For all underground bends (horizontal and vertical) in duct banks that are 45º or more.
      5) For non-encased underground conduit.
      6) For VFD to motor runs.
      7) For conduit lighting runs for single conduits non-encased (an alternative to Rigid Nonmetallic Conduit (RNC) encased)
   b. Rigid Nonmetallic Conduit (RNC): Schedule 40 PVC conduit. (NEC Article 352)
      1) For masonry walls.
      2) For concrete encased duct bank runs.
      3) For conduits embedded in structural concrete slabs.
      4) For under structural slabs.
   c. Electrical Metallic Tubing (EMT) (NEC Article 358):
      1) For metal stud walls where shown on CONTRACT DRAWINGS.
      2) For above ceilings where shown on CONTRACT DRAWINGS.
      3) EMT is not to be used in buildings which have PVC coated rigid metal conduit systems. Suitable for use in existing buildings where corrosive/hazardous conditions removed.

B. Coordination:
1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, lighting fixtures and other systems and equipment and locate so as to avoid interferences.
2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, water stops and expansion joints.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. National Electrical Code (NEC) current adoption.
   2. UL Standard No. 6, Rigid Metal Electrical Conduit.
   3. UL Standard No. 651, Schedule 40 and 80 PVC Conduit.
   4. ANSI C80.4, Fittings for Rigid Metal Conduit and Electrical Metal Tubing
   5. NEMA TC2, Electrical Plastic Tubing, Conduit and Fittings.
   6. NEMA TC3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   7. NEMA RN 1, Polyvinyl Chloride (PVC) Externally Coated Rigid Metal Conduit and Intermediate Metal Conduit
   8. TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces
   9. BICSI Customer-Owned Outside Plant Design Manual

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer’s catalog cuts for the conduit, fittings, supports, conduit identification tags, orange electrical ID tape, and warning ribbon proposed for use. Provide engraved samples of conduit identification tags.
   2. Construction details of conduit racks and other conduit support systems.
   3. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete and conduits directly buried in earth. Drawings shall show locations of intermediate termination panels (ITP's), pull boxes and penetrations in walls and floor slabs. Drawings of embedded conduits shall include cross-sections showing the thickness of the concrete slabs and the locations of conduits with respect to reinforcing steel and waterstops. Tag conduits per conduit schedule shown on drawings.
   4. Drawing shall be electronically produced to maintain quality and clarity of presentation when re-produced, even when reduced to half size (11” x 17”).
   5. Provide manufacturer’s proof of certification for PVC coated rigid metal conduit for all installer’s supervisors.

B. Record Drawings: Show the actual routing of exposed and concealed conduit runs on the Record Drawings conforming to the requirements of Section 01 78 39, Project Record Documents.

PART 2 - PRODUCTS

2.1 MATERIALS - CONDUIT AND CONDUIT FITTINGS

A. PVC Coated Rigid Metal Conduit:
   1. Conduit, Elbows and Couplings:
      a. Material: Rigid, heavy wall, mild steel, interior coating of 2-mil thick urethane, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size for exposed, 1 inch for embedded, encased, or otherwise

inaccessible, with a factory exterior coating of 40-mil thick polyvinyl chloride.

b. Color: All PVC coated materials shall be standard dark gray.

c. Tools: Power drives, chucks, z-wrenches, vises, and cutting or bending tools shall follow recommendations for tooling in manufacturer's installation guide. Use touch-up compounds recommended by the manufacturer for repair of minor damage to interior urethane or exterior PVC factory coatings.

d. Manufacturer: Provide conduit and fittings of one of the following:
   1) Robroy Industries, "Perma-Cote".
   2) Robroy Industries, "Plasti-Bond".
   3) OCAL Inc.
   4) Allied Tube and Conduit/Calbond

2. Fittings and Outlet Bodies:
   a. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with a factory coating of 40-mil thick polyvinyl chloride, an interior coating of 2-mil thick urethane and Form 7 tongue-in-groove V-seal gasket on sizes ½" through 2". Conduit or fittings having areas with thin or no coating shall be unacceptable. Do not use "LB" fittings for conduit sizes of 1¼" or larger. Use type "LBD" fittings wherever the use of fittings for conduit sizes of 1¼" or larger is unavoidable. All units shall be threaded type with five full threads. Material shall conform to ANSI C80.4.
   b. Use: Provide conduit fittings and outlet bodies in all corrosive locations.
   c. Manufacturer: Provide PVC coated conduit fittings and outlet bodies of one of the following:
      1) Robroy Industries, "Perma-Cote".
      2) Robroy Industries, "Plasti-Bond".
      3) OCAL Inc.
      4) Allied Tube and Conduit/Calbond
3. Conduit Hubs:
   a. Material: Threaded conduit hub, vibration proof, weatherproof with captive O-ring seal, zinc metal with insulated throat and factory coating of 40-mil thick polyvinyl chloride and smooth urethane interior coating.
   b. Use: Provide for all PVC coated conduit terminations to boxes, cabinets and other enclosures located in all areas.
   c. Locknuts are not allowed. Use hubs only.
   d. Manufacturer: Provide one of the following:
      1) Robroy Industries, "Perma-Cote".
      2) Robroy Industries, "Plasti-Bond".
      3) OCAL Inc.
      4) Allied Tube and Conduit/Calbond

B. Rigid Nonmetallic Conduit:
   1. PVC Plastic Conduit:
      a. Conduit Material: Schedule 40 PVC plastic, 90°C rated, conforming to NEMA TC-2 and UL No. 651.
      b. Fittings: Elbows, bodies, terminations, expansions and fasteners of same material and manufacturer as base conduit. Materials shall conform to NEMA TC-3 and UL No 514.
      c. Provide cement and primer by same manufacturer as base conduit.

d. Manufacturer: Provide conduit and fittings of one of the following:
   1) PW Eagle
   2) Prime Electrical Products
   3) Cantex

C. Electrical Metallic Tubing:
   1. Elbows, Fittings, and Couplings:
      a. Material: Rigid-type mild steel, galvanized (zinc) exterior, organic lubricated interior, threadless 3/4-inch NPS minimum size.
      b. Couplings and connections: Compression or threaded type only. Set screw type shall not be permitted.
      c. Elbows: Factory formed of same material specified for EMT conduit.
      d. Certifications: Material shall conform to UL-797, ANSI C80.3. Conduit, elbows, couplings, etc. shall bear UL listing and manufacturer's name.
      e. Use of EMT type raceway systems shall only be permitted where specified in Paragraph 1.1.A.4.c, above.
      f. Manufacturer: Provide EMT conduit, elbows, fittings and couplings of one of the following:
         1) Allied Tube and Conduit.
         2) LTV Steel Tubular Products Company.
         3) Wheatland Tube Company.

2.2 MATERIALS - MISCELLANEOUS FITTINGS

A. Conduit Bushings:
   1. Insulated Bushings: Malleable iron body with plastic liner, threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
   2. Use: Provide for all conduit terminations to boxes, cabinets, other enclosures and raceways not requiring a hub.
   3. Manufacturer: Provide one of the following:
      a. O-Z/Gedney.
      b. Appleton Electric Company.
      c. Thomas and Betts.

B. Conduit Tags:
   1. Tag all conduits at the ends and in all intermediate boxes, chambers, hand holes and other enclosures.
   2. Conduit tags shall be yellow, 1-1/2-inch diameter, round, aluminum tags, laser engraved or standard engraving with the conduit number as shown on the Conduit and Cable Schedule. Punched or stamped lettering is not allowed. Font shall be 1/4-inch Arial or Helvetica. The conduit tags shall be manufactured by Brady, Catalog No. 49900, Or Equal.
   3. Each tag shall be attached with nylon-coated 48-mil stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and zinc wire clamps, double ferrule design, as manufactured by Brady Catalog No. 38090 to secure the stainless steel wire. Where this method is not practical, fasten to the adjacent masonry by means of expansion bolts.

C. Warning Ribbon:
   1. Over all underground duct banks and direct cables, install warning ribbon approximately 12-inches below finished grade and centered on direct buried

cables, electrical ductbanks and conduits without ductbank encasement. Provide 6-inch wide, 4-mil thickness underground metallic-lined marking tape with red polyethylene film on top and with clear polyethylene film on the bottom. The tape shall be permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".

2. Manufacturers: Provide one of the following:
   a. Brady "Identoline"; Services and Materials "Buried Underground Tape"
   b. Somerset (Thomas & Betts) "Protect-A-Line"

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in conformance of NEC, Articles 344, 352 and 358. Cap all conduits, ducts and raceways during construction to protect from debris entering and blocking the circuit installation.

B. Supports:
   1. Rigidly support conduits by clamps, hangers or strut channels.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers with Type 316 Stainless Steel horizontal members and Type 316 Stainless Steel threaded hanger rods, Kindorff or equal. Rods shall be not less than 3/8-inch diameter.
   3. PVC coated rigid metal conduit runs, beam clamps, U-bolts, pipe straps, clamp back spacers, clamp hangers and supports shall have a factory applied PVC coating or be stainless steel. Hardware shall be Type 316 Stainless Steel.
   4. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures by the following methods:
   1. To Wood: Type 316 Stainless Steel wood screws.
   2. To Hollow Masonry Units: Type 316 Stainless Steel toggle bolts.
   3. To Brick Masonry: Type 316 Stainless Steel Price expansion bolts, or equal.
   4. To Concrete: Refer to spec section 05 05 19.
   5. To Steel: Type 316 stainless steel welded threaded studs, beam clamps or bolts with lock-washers or locknuts.

D. PVC Coated Rigid Metal Exposed Conduit:
   1. Install in strict accordance with manufacturer's recommendations and installation manual. Installers shall be certified by the manufacturer before installation begins.
   2. Install with manufacturer's installation tools and compounds to prevent damage to the PVC coating.
   3. Repair minor damage to interior urethane and exterior PVC coating with manufacturers recommended touch-up compound.
   4. Install parallel or perpendicular to structural members or walls.

5. Wherever possible, run in groups. Provide conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at manufacturer's recommended distances, or at every ten feet minimum.
6. Install on structural members in protected locations.
7. Locate clear of interferences.
8. Maintain 6-inches from hot fluid lines and 1/4-inch from walls.
9. Install vertical runs plumb. Unsecured drop length not to exceed 12 feet.
10. Provide necessary reducers where equipment furnished cannot accept 3/4-inch conduit.

E. Conduit Embedded in Structural Concrete:
1. Separation: Three times outer diameter of larger conduit center to center.
2. Minimum Slab Thickness: Confirm that concrete slab thickness is sufficient for embedding conduits.
   a. For embedding conduit sizes up to 1-1/2 inches, the minimum slab thickness shall be 7-inches plus the outer diameter of the conduit or conduits, where conduits cross.
   b. For embedding conduits larger than 1-1/2 inches, the minimum slab thickness shall be five times the outer diameter of the conduit where conduits do not cross and six times the outer diameter of the larger conduit where conduits do cross.
3. Concrete shall have a minimum 28-day compressive strength of 2,000 PSI. Concrete used for ductbanks shall be Type 2 with red color added as specified in "Cast-In-Place Concrete (Large Projects)" Section 03 30 00.
4. Run conduits in center of slab, where applicable.
5. Run conduits in spacers to maintain recommended minimum, even spacing.
6. Run conduits above waterstops.
7. Before concrete is placed, make the necessary location measurements of the conduits to be embedded so that the information is available to prepare Record Drawings.
8. All conduits entering or exiting concrete shall be PVC coated galvanized rigid metal, for a minimum of 12-inches from the concrete edge.

F. Underground Conduits that are non-encased: PVC coated rigid metal conduits.
1. Install individual underground conduits a minimum of 24-inches below grade, unless otherwise shown on the Drawings or as required to avoid existing obstructions.
2. Perform all excavation, bedding, backfilling and surface restoration including pavement replacement, where required.
3. Install warning ribbon 12-inches below finished grade over all conduits.
4. Make conduit connections watertight by applying PVC touch-up compound at the sealing sleeve joints.

G. Empty Conduits:
1. Spare conduits shall be cleaned, swabbed, and mandreled to verify viability for future use.
2. Install a true tape or mule tape in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose. Pulling rope or tape shall be constructed of polyester and factory lubricated. Nylon is not allowed.

3. Identify each empty conduit with a conduit tag conforming to the requirements of Paragraph 2.1.G., above, showing the conduit number shown on the Drawings.

H. Field Bends: Use manufacturer supplied field bends whenever possible. No indentations. Diameter of conduit shall not vary more than 15 percent at any bend. Maximum total amount of bends shall not exceed 270°. Length of run between manholes shall be limited to:
   1. 300 feet with 270° in bends.
   2. 600 feet with 180° in bends.
   3. 1000 feet with 90° in bends.

I. Joints:
   1. Make joints tight and ground thoroughly.
   2. Use standard tapered pipe threads for conduit and fittings.
   3. Cut conduit ends square and ream to prevent damage to wire and cable.
   4. Use a degreasing spray to thoroughly clean field cut threads, and internal reams to insure the touch-up compound will adhere to the unprotected metal.
   5. Apply urethane touch-up compound to all joints, field cut threads, and internal reams before assembly for corrosion protection and visible identification of proper installation.
   6. Use full threaded couplings. Split couplings not permitted.
   7. During installation, install with manufacturer's installation tools to prevent damage to PVC coating. Replace conduit with wrench marks.

J. Moisture Protection:
   1. Plug or cap conduit ends at time of installation to prevent entrance of moisture or foreign materials.
   2. Make underground and embedded conduit connections water-tight.
   3. Through Wall Seals and Conduit Sealing Bushings: Install for all conduits passing through concrete slabs, floors, walls or concrete block walls via cored opening. Encased conduit does not require sealing bushings.
      a. For conduits and cables in new construction and passing through exterior subsurface walls and exterior concrete walls, use Type WSK and WSCS through wall seals as manufactured by O-Z/Gedneyl.
      b. For conduits and cables in new construction and passing through concrete floors and floor slabs, use Type FSK and FSCS floor seals, as manufactured by O-Z/Gedney.
      c. For conduits passing through new exterior block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs and roof slabs, use Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure. Sealing bushings shall be as manufactured by O-Z/Gedney.
      d. For conduits passing through existing interior concrete walls or floors and interior block walls, provide CSMC or CSMI type sealing bushings as manufactured by O-Z/Gedneyl.
   4. Drainage: Pay particular attention to drainage for conduit runs. Wherever possible, install conduit runs so as to drain to one end and away from

buildings. Avoid pockets or depressions in conduit runs. Where conduits enter buildings below grade, seal inside of conduit to form a watertight seal around cables to prevent the entry of water into building.

a. Product and Manufacturer: Provide one of the following:
   1) Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney
   2) Type FST Foam Sealant, as manufactured by American Polywater Corp

5. Seal all conduit openings within control and instrumentation panels and distribution equipment with Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney, to provide a water/bug-tight seal.
   a. Product and Manufacturer: Provide one of the following:
      1) Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney
      2) Type FST Foam Sealant, as manufactured by American Polywater Corp

K. Corrosion Protection:
   1. Conduit Curb:
      a. For conduits routed in concrete slabs or floors and stub-ups through the floor, provide a 2-inch high concrete curb, extending 2-inches from the outer surface of the conduit penetrating the floor, to prevent corrosion. For floor-mounted equipment, the concrete equipment base shall be in lieu of the concrete curb.
      b. Conduit stub-ups shall be a 90 degree PVC coated rigid metal conduit elbow. PVC coated elbow shall extend slightly above the top of the concrete curb or equipment base. Should the elbow not reach this height, provide PVC coated conduit extension to accommodate requirements. Provide PVC coated coupling/fitting for transition from conduit in slab to elbow.
      c. For conduits stubbing up and terminating at equipment enclosure mounted on a concrete equipment base, provide RNC stub-up and bell end.
      d. For conduits stubbing up and extending to boxes, cabinets and other enclosures above the concrete curb in wet and dusty areas provide PVC coated conduit coupling/fittings between the PVC coated elbow and PVC coated rigid metal conduit for transition between the two conduit types.
      e. For conduits stubbing up and extending to boxes, cabinets and other enclosures above the concrete curb or equipment base in corrosive areas, continue the conduit system with PVC coated rigid metal conduit.
      f. Conduit into a protected base or equipment enclosure shall be RNC with RNC bell end.
   2. Dissimilar Metals: Take every action to prevent the occurrence of electrolytic action between dissimilar metals

L. Reused Existing Conduits:
   1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
   2. Repeat swabbing until all foreign material is removed.
   3. Pull mandrel through conduit, if necessary, to remove obstructions.

M. Core drill for individual conduits passing through existing concrete slabs and walls. Obtain authorization from OWNER and STRUCTURAL ENGINEER prior to core drilling. Prior to core drilling, drill sufficient number of small exploratory holes (and/or X-ray) to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit in accordance with Section 01 73 29, Cutting and Patching, and the wall penetration details as shown on the Drawings.

N. Non-metallic Conduit:
   1. Install in accordance with manufacturer's recommendations.
   2. Join sections in accordance with manufacturer's installation procedures for push-fit, bell and spigot type joints, if applicable, or with manufacturer's recommended cement and primer.
   3. During installation provide expansion fittings for expansion and contraction to compensate for temperature variations. Expansion fittings shall be watertight and of the type suitable for direct burial.
   4. Make transition to PVC coated galvanized rigid metal conduit before making turns into enclosures, cabinets, termination boxes, pull boxes, etc.
   5. For expansion/deflection fittings as needed.

O. Wall Penetrations:
   1. CONTRACTOR shall ensure conduits that penetrate walls allow for the maintenance of minimum bend radius during the installation of cable.
   2. Submit shop drawings for approval for each wall penetration.

3.2 TESTING

A. Test conduits by pulling through each conduit a cylindrical mandrel not less than two pipe inside diameters long, having an outside diameter equal to 90 percent of the inside diameter of the conduit.

B. All conduits greater than 1.5 inches in size shall be swabbed and mandrel cleaned. This process shall be 100 percent witness inspected and each conduit inspection shall be identified and documented.

+ + END OF SECTION + +

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SECTION 26 05 33.15

FLEXIBLE CONDUIT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install flexible metallic conduit and fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. Phoenix Electrical Code, Article 350, Liquid-Tight Flexible Metal Conduit.
   2. UL Standard No. 360, Liquid-Tight Flexible Steel Conduit.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for flexible conduit and fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flexible Conduit (Non-hazardous Areas):
   1. Material: Flexible galvanized steel core with smooth, abrasion resistant, liquid-tight, polyvinyl chloride cover and color to be black. Continuous copper ground built in for sizes 3/4-inch through 1-1/4-inch. Material shall be UL listed.
   2. Product and Manufacturer: Provide one of the following:
      a. Sealtite UA by Anaconda Metal Hose Division, Anaconda American Brass Company.
      b. Liquatite Type L.A. by Electric-Flex Company.
      c. Or equal.

B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):
   1. Material: Flexible brass inner core with bronze outer braid. Steel, brass or bronze end fittings. Minimum of 12-inches in length.
   2. Product and Manufacturer: Provide one of the following:
      a. Type ECGJH or ECLK by Crouse Hinds Company.
      b. Type EXGJH or EXLK by Appleton Electric Company.
      c. Or equal.

C. Flexible Conduit Fittings:
   1. Material and Construction: Malleable iron with zinc electroplating finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
   2. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.
   3. Product and Manufacturer: Provide one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.

D. PVC Coated Conduit Fittings:
   1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size.
   2. Use: Provide on flexible conduit in areas designated as corrosive locations.
   3. Product and Manufacturer: Provide one of the following:
      a. Robroy Industries.
      b. Permacote Industries.
      c. OCAL Incorporated.
      d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with Phoenix Electrical Code requirements.

+ + END OF SECTION + +

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SECTION 26 05 33.17

PULL BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install pull boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix Electrical Code, Article 370, Outlet, Switch and Junction Boxes, and Fittings.
   2. UL Standard No. 50, Electrical Cabinets and Boxes.
   3. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for pull boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pull Boxes: Provide boxes based upon location in accordance with NEMA requirements and as required for the area classification specified in Section 16050, General Provisions.
   1. Material and Construction:
      a. Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.
      b. Neoprene gaskets. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable.
      c. Stainless steel cover bolts.
      d. External mounting lugs.
      e. Drilled and tapped conduit holes.
      f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole.
   2. Product and Manufacturer: Provide pull boxes of one of the following:
      a. Appleton Electric Company.
      b. O-Z/Gedney Company.

c. Hoffman Engineering Company.
d. Or equal.

3. Large boxes not generally available in cast construction may be fabricated of copper-free aluminum alloy or Type 316 stainless steel as required by location.
4. Boxes for installation in areas classified as hazardous locations shall be explosion-proof and shall comply with the requirements of UL Standard No. 886.
5. For flush-mounted pullboxes in slabs or pavement, provide vehicular traffic-bearing covers, where shown on the Drawings.
6. Pull boxes embedded in concrete slabs shall be cast iron. Pull boxes located in wet, corrosive or outdoor areas shall be NEMA 4X, Type 316 stainless steel. All other areas shall be NEMA 12.
7. All boxes shall be identified in accordance with Section 16050, General Provisions.
8. All inside plant pull boxes used for communications, signal, or fiber optic cabling shall meet the requirements listed in table below:

Maximum Trade Size of Conduit (inches)	**Minimum Box Size (inches)**			**For Each Additional Conduit Increase Width (Inches)**
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain a minimum of 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which they are mounted. Provide independent stainless steel or FRP supports where no walls or other structural surface exists. Do not locate pull boxes on handrails.

C. Install pull boxes where shown on the Drawings. In addition, install pull boxes in conduit runs containing more than three 90 degree bends and in runs exceeding 200 feet. For communications, signal, and fiber optic cabling conduit runs install pull boxes in runs containing more than two 90 degree bends and in runs exceeding 100 feet.

D. Provide removable, flame-retardant, insulating cable supports in all boxes with any dimension exceeding three feet.

E. Field apply PVC touch up to scratched PVC boxes damaged as a result of installation. All touch up work shall be in strict conformance with manufacturer's recommendations and instructions.

F. Size pull boxes in accordance with the requirements of the Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 26 05 33.18

OUTLET BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install pull boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix Electrical Code, Article 314, Outlet, Switch and Junction Boxes, and Fittings.
   2. UL Standard No. 50, Electrical Cabinets and Boxes.
   3. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for pull boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pull Boxes: Provide boxes based upon location in accordance with NEMA requirements and as required for the area classification specified in Section 26 05 01, General Provisions.
   1. Material and Construction:
      a. Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.
      b. Neoprene gaskets. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable.
      c. Stainless steel cover bolts.
      d. External mounting lugs.
      e. Drilled and tapped conduit holes.
      f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole.
   2. Product and Manufacturer: Provide pull boxes of one of the following:
      a. Appleton Electric Company.
      b. O-Z/Gedney Company.
      c. Hoffman Engineering Company.

d. Or equal.

3. Large boxes not generally available in cast construction may be fabricated of copper-free aluminum alloy or Type 316 stainless steel as required by location.
4. Boxes for installation in areas classified as hazardous locations shall be explosion-proof and shall comply with the requirements of UL Standard No. 886.
5. For flush-mounted pullboxes in slabs or pavement, provide vehicular traffic-bearing covers, where shown on the Drawings.
6. Pull boxes embedded in concrete slabs shall be cast iron. Pull boxes located in wet, corrosive or outdoor areas shall be NEMA 4X, Type 316 stainless steel. All other areas shall be NEMA 12.
7. All boxes shall be identified in accordance with Section 26 05 01, General Provisions.
8. All inside plant pull boxes used for communications, signal, or fiber optic cabling shall meet the requirements listed in table below:

Maximum Trade Size of Conduit (inches)	**Minimum Box Size (inches)**			**For Each Additional Conduit Increase Width (Inches)**
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain a minimum of 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which they are mounted. Provide independent stainless steel or FRP supports where no walls or other structural surface exists. Do not locate pull boxes on handrails.

C. Install pull boxes where shown on the Drawings. In addition, install pull boxes in conduit runs containing more than three 90 degree bends and in runs exceeding 200 feet. For communications, signal, and fiber optic cabling conduit runs install pull boxes in runs containing more than two 90 degree bends and in runs exceeding 100 feet.

D. Provide removable, flame-retardant, insulating cable supports in all boxes with any dimension exceeding three feet.

E. Field apply PVC touch up to scratched PVC boxes damaged as a result of installation. All touch up work shall be in strict conformance with manufacturer's recommendations and instructions.

F. Size pull boxes in accordance with the requirements of the Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 26 05 36

CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install cable trays.

B. Coordination: Coordinate installation of cable trays with piping, ductwork, lighting fixtures and other systems and equipment and locate clear of interferences.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified.
   1. Phoenix Electrical Code, Article 392, Cable Trays.
   2. NEMA VE 1, Cable Tray Systems.
   3. ASTM A 386, Specifications for Zinc Coating (Hot-Dip) on Assembled Steel Products.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for the cable tray system proposed for use.
   2. Layout drawings, fill calculations, and load calculations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cable Tray System:
   1. Type: Ladder, rungs welded to side rails.
   2. Material: Aluminum.
   3. Rung Spacing: 9-inches on center, minimum.
   4. Inside Depth: 5-inches, minimum or as otherwise shown on the Drawings.
   5. Radius: As shown on the Drawings, specified or required.
   6. Width: 6 to 36-inches as shown on the Drawings, specified or required.
   7. Support Span: Not to exceed 12-feet, unless otherwise shown on the Drawings..
   8. Loading Capacity: NEMA 12C or greater.

B. Supports and Support Hardware:
   1. All supports and support hardware shall be Type 316 stainless steel.

C. Transition to and from the Cable Tray:
   1. Support cables going to and from the cable tray using Kellum grips.

2. Route cables between the cable tray and the equipment through conduits.

D. Product and Manufacturer: Provide one of the following:
1. Husky Products Incorporated.
2. Robroy Industries.
3. B-Line Systems.
4. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cable trays in conformance with Phoenix Electrical Code and manufacturer's instructions and recommendations as complete systems prior to the installation of cables.

B. Install cable trays exposed and in accessible locations.

C. Ground all cable tray system components.

D. Where required, connect conduit to tray using listed cable tray conduit clamps, B-Line Catalog Number 9ZN-1158, or equal.

E. Furnish all required fittings and transitions for tie-ins to existing cable tray systems.

F. Furnish barrier strips in all trays to isolate instrumentation and communication cables from power and discrete control wiring.

+ + END OF SECTION + +

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SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install conduit sealing fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix Electrical Code, Article 500, Hazardous (Classified) Locations.
   2. UL Standard 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for sealing fittings proposed for use.
   2. Listing of locations where fittings are to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Construction:
   1. Cast gray iron alloy or cast malleable iron or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.
   2. Ample opening with threaded closure for access to conduit hub for making dam.
   3. In corrosive locations, fittings shall include a factory applied 40-mil PVC coating.

B. Sealing fiber for forming the dam within the hub and the sealing compound shall be approved for use with the fittings furnished, and shall be products of the fitting manufacturer.

C. Product and Manufacturer: Provide one of the following:
   1. Crouse Hinds Company.
   2. Appleton Electric Company.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install for hazardous locations as required by Phoenix Electrical Code, and where as shown on the Drawings.

B. Select a fitting for the proper use in respect to the mounting position.

C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

+ + END OF SECTION + +

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SECTION 26 05 44.11

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install conduit expansion and deflection fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) current adoption.
   2. UL Standard 514, Electrical Outlet Boxes and Fittings.
   3. UL Standard 467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for expansion and deflection fittings proposed for use.
   2. Listing of locations where fittings are to be installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast gray iron alloy or bronze end couplings, malleable iron or hot dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper for fittings that do not utilize an internal bonding jumper. Fitting to be watertight, corrosion-resistant UL listed and compatible with the conduit system.

B. Features:
   1. Expansion/Deflection Fittings.
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees.
      c. Parallel misalignment up to 3/4-inch.
   2. Expansion Fittings.
      a. Expansion/Contraction, 8-inch total movement.

C. Product and Manufacturer: Provide one of the following:
   1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.

2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
3. Type DF for expansion/deflection or XJ for expansion only by Appleton Electric Company.
4. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fittings in conformance with NEC.

B. Install expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Install expansion fittings on exposed conduit runs exceeding 200 feet.

C. Install expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Install fittings above waterstops.

D. In addition to as stated above, install expansion/deflection fittings as shown on CONTRACT DRAWINGS.

E. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid to PVC adapters for connection to fittings. Ensure that joints exposed to water are made watertight.

+ + END OF SECTION + +

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SECTION 26 05 73

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. General:
1. Conduct a Power System Short Circuit Study, Protective Device Coordination Study, and Arc Flash Hazard Analysis for the Electrical Distribution System (EDS) as specified in the CONTRACT DOCUMENTS.
2. The CONTRACTOR shall coordinate with the City's Electrical, Instrumentation and Control Inspection Firm (EI&C Inspector) as outlined in this specification to perform the POWER SYSTEM / ARC FLASH HAZARD ANALYSIS. The EI&C Inspection Firm will perform the POWER SYSTEM / ARC FLASH HAZARD ANALYSIS and shall here in be referred to as ANALYSIS FIRM.
3. The software used to conduct the study and analysis shall be the latest version of SKM Power*Tools, by SKM Systems Analysis, Inc.

1.2 SCOPE

A. CONTRACTOR Scope:
1. The CONTRACTOR shall be responsible for providing the following data to the ANALYSIS FIRM:
   a. Project Schedule.
   b. Electrical Utility contact information.
   c. Division 26 Engineer approved submittals, including the ENGINEERS review comments.
   d. Additional equipment information as requested by the ANALYSIS FIRM per Section 1.2.A3.
   e. Marked up single line diagram(s) with installed conductor lengths, sizes and count.
   f. Changes in design as a result of RFI's, Addendums, Engineer Clarifications, Sketches or revisions, which may affect the Power System / Arc Flash Analysis.
2. CONTRACTOR shall provide ANALYSIS FIRM a minimum of a 2-week notice of the following construction milestones:
   a. Electrical Equipment Delivery.
   b. Electrical Equipment Energization.
   c. Electrical Equipment Testing.
   d. Substantial Completion.
3. Based upon outcome of analysis additional equipment information may be required by the CONTRACTOR for upstream or downstream equipment in the electrical distribution system.
4. CONTRACTOR shall be responsible for implementation of the protective device settings. Implementation of recommended settings outside of the

project scope of work resulting from system coordination changes is the responsibility of the OWNER.

5. CONTRACTOR shall provide ANALYSIS FIRM with safe access to all equipment on site throughout construction for the purpose of verifying the EDS protective device information.
6. CONTRACTOR shall install labeling as required by specification 26 05 01 section 3.1 for voltage labeling and other labels as required.

B. ANALYSIS FIRM Scope
1. Conduct a Power System/Arc Flash Hazard Analysis for new and modified areas of the EDS as specified in the CONTRACT DOCUMENTS. The analysis shall be performed in accordance with IEEE and shall utilize the ANSI method of short circuit analysis. An SKM model of the EDS shall be developed or modified using ENGINEER'S approved Equipment Submittals, site collected data, and Utility short circuit data. Deliverables shall include a short circuit analysis results, a protective device coordination analysis results, and arc flash / shock hazard analysis results and work tasks required by the CONTRACTOR. The ANALYSIS FIRM shall coordinate new protective devices with existing protective devices in the EDS as required.
2. Where additional electrical equipment is being added or modified and upon request from the ANALYSIS FIRM, the entity having the documentation will transmit the existing Arc Flash Documentation to the ANALYSIS FIRM for use in completing the required updates.
3. ANALYSIS FIRM shall acquire the Electrical Utility Company's published available Short Circuit current tables for use in the studies. For larger service sizes greater than 480VAC, the ANALYSIS FIRM is to coordinate with the Utility Company for calculated available short circuit current.
4. ANALYSIS firm shall verify that protective devices are correct per SKM model and analysis results.
5. ANALYSIS FIRM shall install Arc Flash Hazard Warning labels per this specification.
6. ANALYSIS FIRM shall install the updated laminated Single Line Diagram's, Panel Schedules, and Load Summaries. Updates will be made by the ANALYSIS FIRM based on as-build documentation provided by the CONTRACTOR.
7. ANALYSIS FIRM shall deliver the final SKM Model and all associated data and library files used in the model to the OWNER. The ANALYSIS FIRM shall relinquish all rights of the SKM model and all associated data and library files to the OWNER.

1.3 REFERENCES

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. IEEE 141-1993, Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book).
2. IEEE 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
3. IEEE 1584-2002, Guide for Performing Arc Flash Hazard Calculations

4. NFPA 70E, Standard for Electrical Safety in the Workplace.
5. IEEE 551, Recommended Practice for Calculating Short-Circuit Currents in Industrial and commercial Power Systems (IEEE Violet Book).
6. NFPA 70, National Electrical Code (NEC).

1.4 SUBMITTALS

A. Preliminary Technical Memorandum:
   1. ANALYSIS FIRM shall provide a preliminary submittal review and a technical memorandum providing comments for equipment submitted on. This will be submitted for review by the ENGINEER and OWNER. Submittal shall include:
      a. Technical Memorandum
         1) Review for adequate installation based on available fault current.
         2) Recommendations for alternate equipment based on system coordination.
         3) Recommendations for alternate design considerations based on energy levels.
   2. Preliminary Technical Memorandum shall be submitted and reviewed by the ENGINEER to ensure EDS electrical equipment order being released for manufacturing meets the requirements of the project.

B. Final Report:
   1. ANALYSIS FIRM shall submit a final sealed report to the CONTRACTOR upon project substantial completion. Final report shall be in PDF format and include all documents as noted in section 1.4.B.2 below.
   2. ANALYSIS FIRM to provide the following documents in the final report:
      a. Final Report
      b. SKM Single Line Diagrams – Power Study Management Scenario
      c. SKM Time Current Curves
      d. Arc Flash Labels

C. Submittals shall be delivered in pdf format, unless otherwise specified. CONTRACTOR shall provide four (4) cd(s) of the final deliverable report to the ENGINEER.

PART 2 - PRODUCTS

2.1 POWER SYSTEM / ARC FLASH ANALYSIS FINAL REPORT

A. Professional Certified Report:
   1. ANALYSIS FIRM shall provide a certified report that shall include but is not limited to:

a. An executive summary.
b. Methods, assumptions, and procedures used in the analysis.
c. Results of short-circuit analysis listing equipment that is applied above its short-circuit current rating, and recommendations if appropriate.
d. Results and recommendations of the protective device coordination and time-current analysis, including time-current curves (TCC's).
e. Documentation of all study input data, including utility available fault currents; cable sizes, types and lengths; motor data; breaker types and settings; fuse sizes and types, etc.
f. Findings and recommendations requiring actions not within the ANALYSIS FIRM scope of work.
g. Electrical Distribution System Overview as illustrated on the CONTRACT DOCUMENTS.
h. Appendices with the SKM documents of the equipment data used in the analysis and the analysis results.

2. Report shall be reviewed and sealed by a Professional Engineer registered in the state of Arizona.

B. SKM Single-Line Diagram(s):
1. SKM Single-Line Diagram(s) legible on 11" x 17" sheet size, landscape view. Include the following information:
a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
b. Type designation, current rating, range or adjustment, manufacturer's style or type for all protective devices.
c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
d. Type, manufacturer, and ratio of all current transformers energizing each relay.
e. Manufacturer's nameplate data of all motors and generators.
f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
h. Normal switching conditions where possible.
i. The final settings of adjustable breakers, relays and direct-acting trips.

C. Short Circuit Study:
1. The short circuit analysis shall be performed to determine the adequacy of circuit breakers, surge arresters, busways, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents. Short circuit momentary duties and interrupting duties shall be calculated on the basis of worst case scenario / maximum available fault current at the switchgear busses and motor control centers.
2. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly addressed in the analysis. The analysis shall assume all motors operating at rated voltage. Redundant/standby motors shall be excluded where known system limitations prevent simultaneous operation. Electrical equipment bus impedance shall be assumed zero (SKM default setting).

D. Protective Device Coordination Study:
   1. The protective device coordination analysis shall be performed to determine the required settings/sizes of the protective devices to maximize selectivity. The phase over-current and ground-fault protection settings shall be included as well as settings for all other adjustable protective devices, excluding vendor supplied packaged equipment. Areas lacking complete coordination shall be identified and justification provided for allowing condition to remain or the ENGINEER and the ANALYSIS FIRM (collectively) shall provide solution to resolve situation.
   2. SKM Time-Current Curve(s) legible on 11" x 17" sheet size, landscape view on 10- cycle, green log-log graph paper. Include the following information for each time-current curve:
      a. Protective device, relay, or fuse showing graphically that the settings provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
      b. Each device shall be positioned to provide maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
      c. Points for cable and equipment damage.
      d. Circuit interrupting device operating and interrupting times based on the amperage.
      e. A SKM Single line sketch of bus and breaker arrangement for each time-current curve.
   3. Provide breaker setting table with sign off form for CONTRACTOR use during implementation of breaker settings.

E. Arc Flash/Shock Hazard Analysis:
   1. The arc flash / shock hazard analysis shall be conducted in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter. Work shall be in accordance with NFPA 70E which includes the fabrication of labels with the Arc Flash / Shock Hazard analysis results, the calculated Incident Energy (cal/cm^2), Equipment Name, Owner and Owner contact information, and the date the analysis was performed.
   2. The analysis shall include the following IEEE 1584 analysis process steps:
      a. Collect current and accurate system and installation data.
      b. Determine modes of operation.
      c. Determine bolted fault current.
      d. Determine arc fault current.
      e. Determine protective device characteristic and arc fault duration.
      f. Document system voltages
      g. Select working distances.
      h. Calculate Incident Energy (cal/cm^2).
      i. Calculate the Arc Flash Boundary.
   3. Within the final report, provide a copy of each installed Equipment Specific Arc Flash label on 8½" x 11" sheet size, portrait view in actual size and color as printed and installed on the actual field equipment.

2.2 LABELS

A. Arc Flash Hazard Warning Labels:
   1. PPE Category Label:
      a. A standard Arc Flash Hazard Warning label (Category Label) shall be installed on all equipment that meets the NFPA 70E Category 1 or 2 parameters, including a maximum of 25 kA available fault current and arc-duration parameters (clearing time). All other components must have an equipment specific label generated from SKM using calculated values as described in 2.2.A.2.
      b. Provide a 2" x 4" label format with coloring to match the labels shown on Figure 2.2.B.1 below.

Figure 2.2.B.1

   2. Calculated Equipment Specific Labels:
      a. Arc Flash and Shock Hazard Warning labels shall be installed on all equipment with an SKM calculated Incident Energy level.
      b. Label shall have an orange header with the wording, "WARNING, Arc Flash and Shock Hazard," and shall include the following information taken directly from the arc flash hazard analysis:
         1) Equipment designation.
         2) Nominal system voltage.
         3) Protection boundaries:
            a) Arc Flash Boundary.
            b) Limited approach boundary.
            c) Restricted approach boundary.

c. Calculated available incident energy in cal/cm^2 and the corresponding working distance.
d. Owner: City of Phoenix
e. Contact Info Phone Number. **(602) 495-7692**
f. Study Date.
g. Labels shall be machine printed, with no field-applied markings.
h. Provide standard 4" x 5" rectangular labels.
i. Provide a label with coloring and formatted to match Figure 2.2.B.2 below.

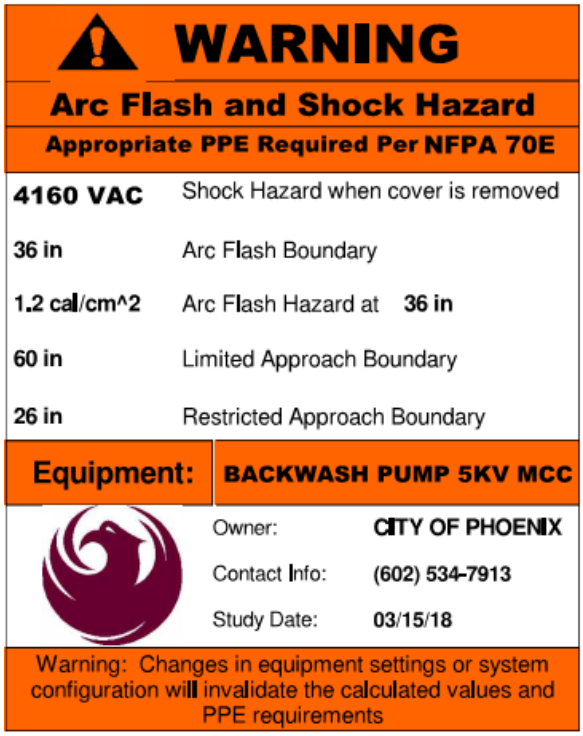

Figure 2.2.B.2

3. Label Material:
   a. Label shall be an indoor/outdoor high performance, pressure sensitive safety sign.
   b. Materials shall be UV rated surface printed polyester with polyester over-laminate. Labels shall be abrasion, chemical and heat resistant (-40°C to 110°C), with an average outdoor durability of five to eight years.
   c. Comply with ANSI Z535.4 for safety signs and labels.
   d. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
   e. Product Manufacture: Provide the following:
      1) Printer and Label Materials
         a) BRADY Powermark Printer, BRADY Label Part# 13651
         b) Or Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

A. ANALYSIS FIRM shall inspect all installed equipment for conformance with the fully executed POWER SYSTEM / ARC FLASH ANALYSIS. Any deviations found shall immediately be brought to the OWNER and ENGINEERS attention.

3.2 BREAKER SETTINGS

A. The CONTRACTOR shall coordinate with the ENGINEER and ANALYSIS FIRM to implement the breaker settings defined in the approved preliminary report submittal.
   1. The CONTRACTOR shall complete form 26 05 73 – A – Power System / Arc Flash Analysis Sign-off Form for each breaker.

B. The ANALYSIS FIRM shall inspect all breaker settings implemented in the field by the CONTRACTOR. If the recommended breaker setting(s) are adjusted, the ANALYSIS FIRM will update the final report with the actual settings. CONTRACTOR is to provide written justification for any deviations.

3.3 BREAKER TESTING

A. The CONTRACTOR shall coordinate the final settings of the breakers during the start-up and functional testing of the process systems EDS. If the breaker settings require adjustment, the CONTRACTOR will coordinate with the ENGINEER and ANALYSIS FIRM to update the Power System Arc Flash Analysis Report with the final settings.

3.4 LABELING

A. All Service Entrance Sections (SES), switchboards, switchgear, Motor Control Centers (MCC), transformers, distribution boards, panel boards, disconnects and control panels shall have both an Arc Flash Hazard Warning label and a voltage label as identified in specification section 26 05 01. The ANALYSIS FIRM shall determine the proper Arc Flash Hazard Warning label.
   1. Install all labels level and in an upright position. Do not cut or alter in any way. Install labels in a professional manner. Clean surface as needed to allow for good adhesion.
   2. Labels shall not be installed atop any manufacturer name plate data or equipment tag labels.
   3. Labels shall not be installed atop any existing voltage warning or Arc Flash Hazard Warning labels that may already exist on the equipment. Existing voltage and Arc Flash Hazard Warning labels shall be removed and the surface thoroughly cleaned before application of any new labels.
   4. Where equipment does not have sufficient space for an Arc Flash Label the CONTRACTOR shall furnish a fabricated mounting plate constructed of stainless steel sheet metal per direction from the ENGINEER. Mounting plate

shall be affixed to the equipment using stainless steel screws. Installation shall maintain the equipment NEMA rating of the equipment. Mounting plate shall not interfere with equipment operation and shall be readily visible.

5. In the case of more than one source of power to a piece of equipment, the highest voltage label shall be applied, and an additional label shall be applied indicating more than one source of power located inside the equipment.
6. For outdoor switchgear, place a single Arc Flash Hazard Warning label on the outside of the access door nearest to the main breaker, and one inside on the respective breaker enclosure. All other Arc Flash Hazard Warning labels shall be placed inside the access doors on the respective breaker enclosure or cover. If there are back access panels to the equipment, the arc flash labels placed at the front of the gear shall be duplicated and placed on the back access panels at the same relative location.
7. For disconnect switches, panel boards, distribution boards, load centers, and control panels, the labels should be applied in plain view on the front cover.

+ + END OF SECTION + +

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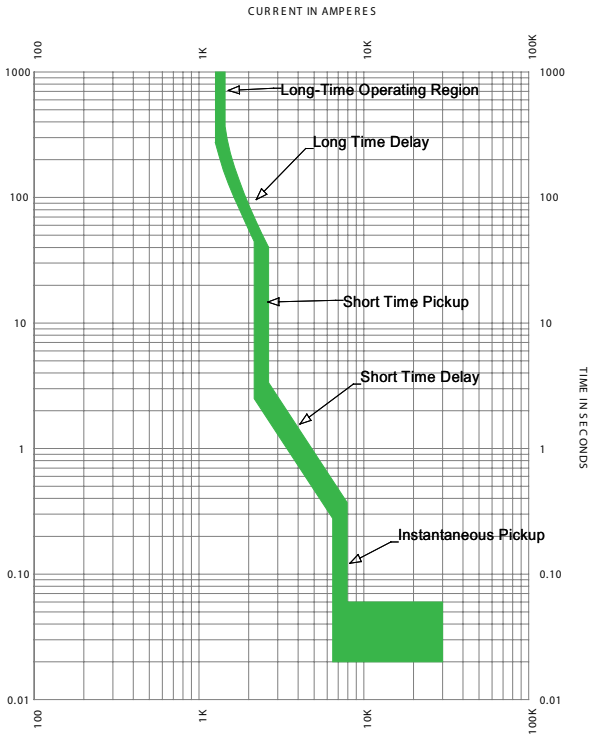
Data Bulletin

Retain for future use

Square D Preferred Methods for Arc-Flash Incident Energy Reduction

INTRODUCTION



Typical Time-Current Curve
Figure 1

WHAT IS ARC FLASH?
According to NFPA 70E-2004, arc flash is a "dangerous condition associated with the release of energy caused by an electrical arc." [1] It is measured in terms of arc-flash incident energy (AFIE), which is used to determine the appropriate level of Personal Protection Equipment (PPE), and in terms of an arc flash protection boundary.

Reducing arc-flash incident energy (AFIE) levels has become an increasingly important consideration in designing electrical power systems. However, selective coordination of overcurrent protective devices is equally important and both are often misunderstood. The best solution is to provide superior AFIE reduction without sacrificing selectivity.

Square D® Masterpact® low-voltage power circuit breakers (LVPCBs) offer increased arc-flash protection thanks to faster clearing times, especially at higher current levels. In addition to superior arc-flash protection inherent in their design, Masterpact® breakers can be configured in a variety of "Zone Selective Interlocking" (ZSI) schemes to further enhance protection with no impact on selectivity. Likewise, Sepam™ overcurrent relays can also be applied in ZSI solutions.

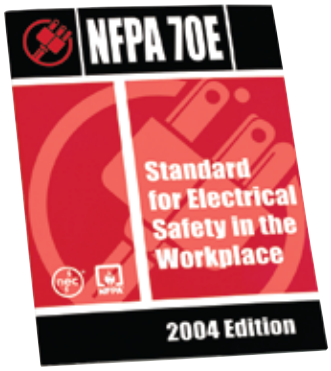
In some cases, simply taking the time to obtain accurate equipment data may allow improved AFIE results without sacrificing selectivity.

In an attempt to respond to the benefits afforded by these successful Square D products, some manufacturers have introduced alternate schemes which reduce AFIE levels by temporarily compromising selective coordination. It is imperative that consultants and end users understand the risks introduced by these compromise schemes as well as the technical considerations that must be addressed.

An Arc-Flash Hazard Analysis must be performed on the system and the associated equipment. The AFIE reduction methods are of no use unless the AFIE levels and protection requirements are known and defined in the analysis.

This bulletin describes Square D preferred methods for AFIE reduction that do not involve compromises to selective coordination. Alternative approaches are also presented, as well as their associated risks and technical issues so that consultants and end users can make informed decisions.

ARC-FLASH INCIDENT ENERGY

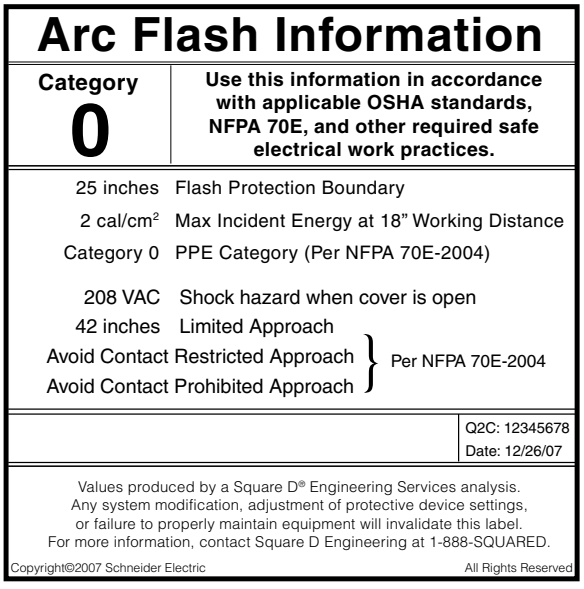


The incident energy associated with an arc is defined as “the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event.” [2] NFPA 70E-2004 defines several “Hazard/Risk Categories” and the prescribed PPE for each, as shown in the table below. The amount of energy is directly proportional to the magnitude of current and its duration. Because the arc duration is controllable, it is often the focus of arc flash reduction techniques. [4]

NFPA 70E - 2004

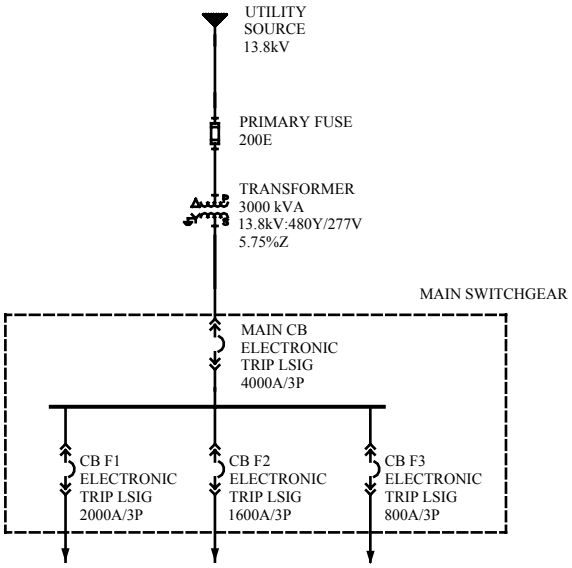
	Typical Protective Clothing Systems	
Hazard Risk Category	Clothing Description (Typical number of clothing layers is given in parentheses)	Required Minimum Arc Rating of PPE [J/cm2(cal/cm2)]
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd2 (1)	N/A
1	FR shirt and FR pants or FR coverall (1)	16.74 (4)
2	Cotton underwear – conventional short sleeve and brief/shorts, plus FR shirt and FR pants (1 or 2)	33.47 (8)
3	Cotton underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear plus two FR coveralls (2 or 3)	104.6 (25)
4	Cotton underwear plus FR shirt and FR pants plus multilayer flash suit (3 or more)	167.36 (40)

Table 130.7(C)(11) Protective Clothing Characteristics
Figure 2



Square D Arc Flash Label
Figure 3

ENSURING OPTIMAL TIME-CURRENT CHARACTERISTICS

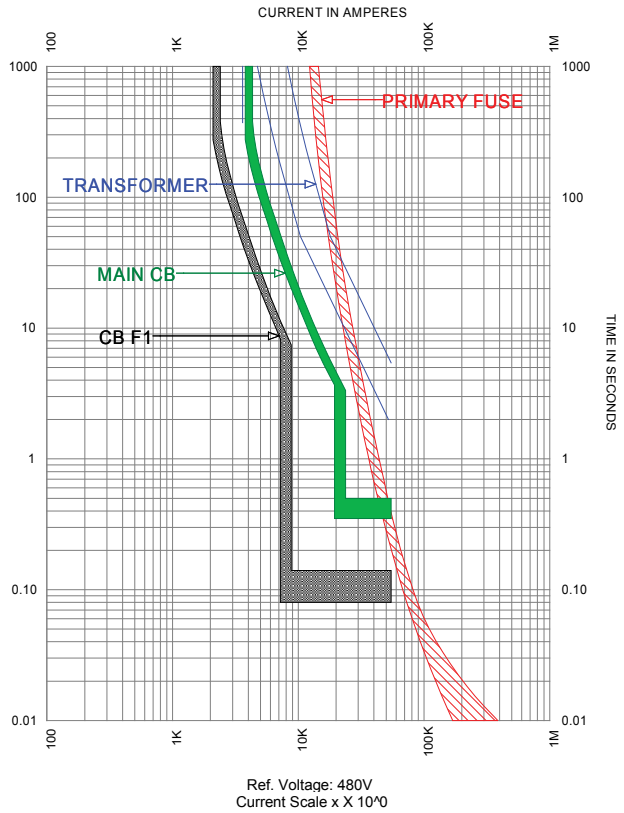


Example System One-Line
Figure 4

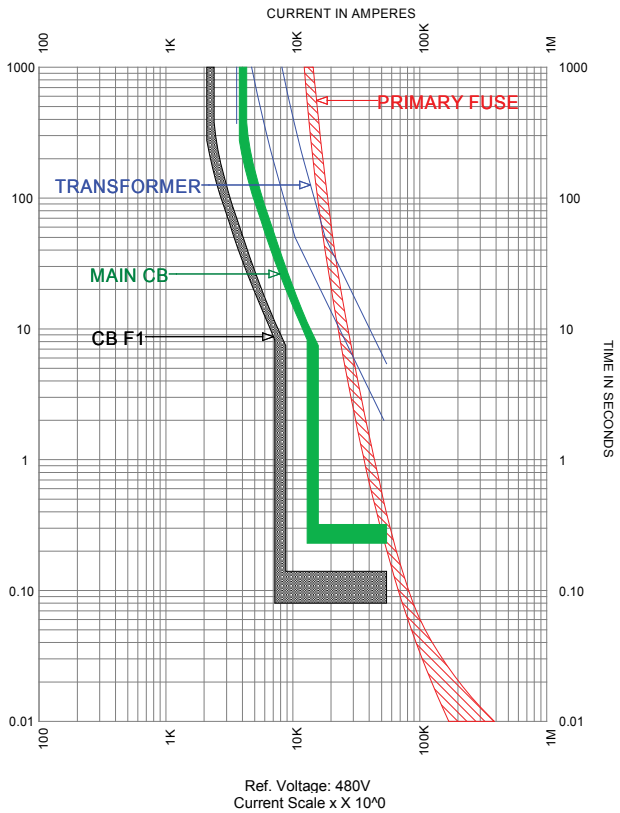
The objective of a short-circuit/time current coordination (SC/TCC) study is to determine the fastest practical time-current characteristic for each protective device while carrying full load and momentary inrush currents and maintaining selective coordination with upstream and downstream protective devices. [5] For example, in order to ensure selective coordination between a main breaker and the largest feeder, the main breaker's short time delay function is set one step higher than the feeder's. That is, a brief intentional delay is introduced for the main breaker in order to allow the feeder breaker time to clear the fault. In this way, the main breaker will not trip unless a) the feeder does not clear the fault or b) the fault is ahead of the feeder breaker (e.g., on the main bus between the feeder and the main).

However, real-world pressures on schedules and budgets often affect time-current coordination results, with an inadvertent impact on arc flash levels. Equipment designs may be finalized long before power system designers have the opportunity to make recommendations. Inadequate attention to data collection may provide system designers without sufficient information on upstream and downstream equipment and loading. Forced to make assumptions, designers may opt for time-current settings higher than needed, just to avoid any possibility of nuisance trips and interruptions to operations. These higher settings sometimes result in higher arc flash levels.

Consider the example below. Given more accurate information about combined inrush current from motors and transformers, it may be possible to reduce the main breaker's short time pickup and delay settings without sacrificing selective coordination. (Figure 5b)



Typical
Figure 5a



Optimal
Figure 5b

MASTERPACT® ARC-FLASH PROTECTION CIRCUIT BREAKERS

Masterpact NW drawout power circuit breaker

Masterpact® NW and NT low-voltage power circuit breakers feature breakthrough technology that provides superior arc flash protection, especially at higher fault currents. They provide arc flash protection comparable to fast-acting current-limiting fuses at high currents and better protection than fuses at lower currents. [6]

Masterpact breakers are tested by Square D and have published AFIE levels, resulting in simplified calculations for the flash-protection boundary.

Masterpact breakers are available in new Square D® equipment, PZ4 low-voltage drawout ANSI switchgear and also in QED6 and QED2 UL-rated switchboards. In addition Square D Services can retrofit Masterpact breakers into existing switchgear, even if the original equipment was not supplied by Square D.

AFIE PERMANENT REDUCTION METHODS
Zone Selective Interlocking

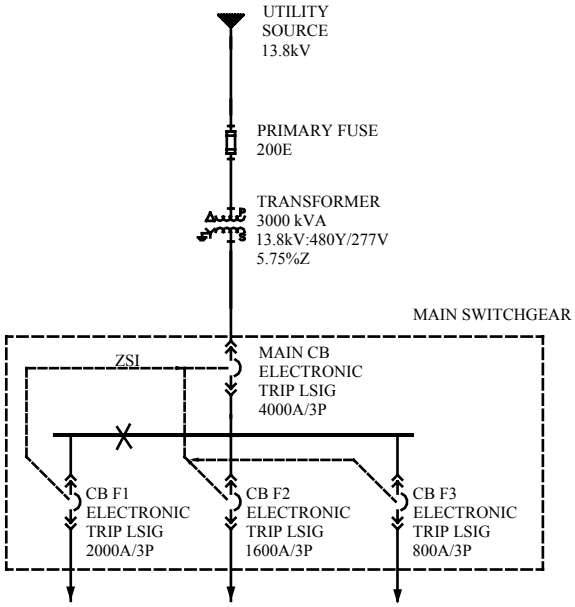


Figure 6

Zone selective interlocking preserves the desired selective coordination between main, tie and feeder protective devices but also allows fast tripping for faults within each device's desired zone. This is accomplished via wired connections between trip units or relays. If a feeder detects an overcurrent condition it sends a restraining signal to upstream breaker(s). The main (and tie) then follows its normal time-current characteristics and serves as a backup. However, if the main breaker detects an overcurrent condition above its short time (or ground fault) pickup setting, but the feeders do not (e.g., main bus fault), then the main breaker will not receive a restraint signal and it will trip with no intentional time delay. (See figure 6) In this way, ZSI offers the "best of both worlds" – fast clearing of fault currents without sacrificing selective coordination. Furthermore, ZSI is available on both low-voltage and medium-voltage equipment, and can be applied for both phase faults and ground fault protection. Like Masterpact arc-flash circuit breakers, this solution is available for both new construction (Square D® power equipment) and retrofit of existing.

Main breaker trips on short time delay for faults on load side of feeders (restraint signal)

Main breaker trips with no intentional delay for bus faults

x=fault

LV Virtual Main with ZSI

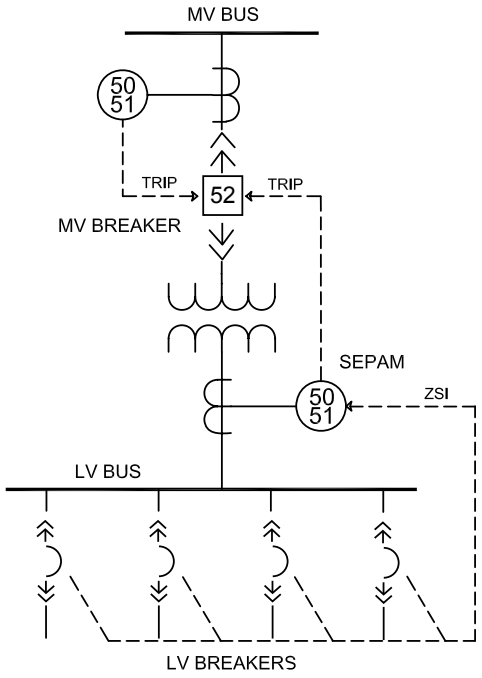


Figure 7

A situation where arc-flash incident energy is typically very high is when the LV bus is fed by a transformer and the overcurrent protection on the transformer primary must see and clear the secondary side fault. This is the case if there is no LV main. An application to reduce the arc-flash energy can be accomplished with a “virtual” main. A Sepam™ protective relay is used to monitor the transformer secondary current and, when it senses a fault, trip the medium voltage (MV) breaker. This assumes a medium voltage breaker feeds a single transformer. (See Figure 7)

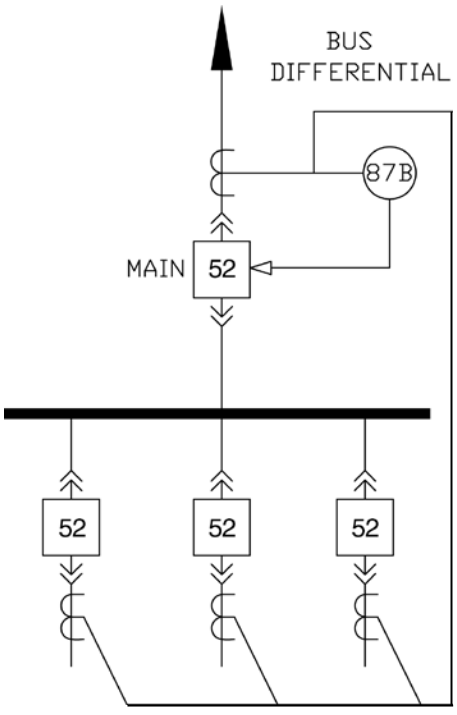
Zone Selective Interlocking (ZSI) is shown with the LV Virtual Main in this scheme to reduce bus arc flash energy potentially even further. For a fault on the load side of a feeder, the feeder circuit breaker sends a signal to the virtual main and it uses the standard settings to coordinate with the feeder. If there is a bus fault, there is no ZSI signal and the virtual main uses a definite time characteristic. The definite time delay will be typically many times faster than the delay necessary for coordination.

The LV virtual main application can also have the advantage over a main circuit breaker application when the CT’s are located in the LV transformer compartment. The protective relay can reduce AFIE for the entire switchgear lineup, whereas a main circuit breaker can only reduce AFIE for the feeder breakers.

Zone Selective Interlocking may also be applied to MV protection. Neither MV equipment nor LV equipment should be worked on when energized. However, there are situations like operating or racking a breaker where reduced arc-flash energy would be desirable. This scheme functions similar to the LV case. If the feeder detects a fault, it sends a ZSI signal to the main relay. The main relay applies its setting for selective coordination. If the main sees a fault and there is no ZSI signal, it applies a minimum time delay, tripping much faster than it would with its normal setting.

BUS DIFFERENTIAL PROTECTION SCHEMES

Differential Relaying Protection



Bus differential protection
Figure 8

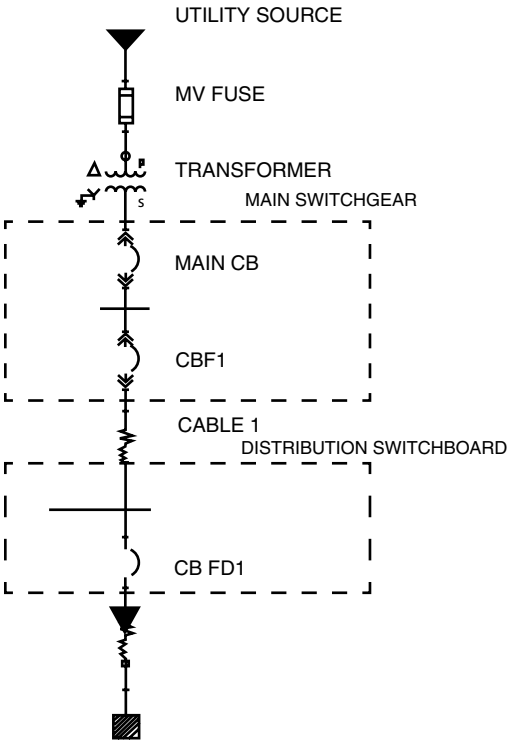
Differential relaying protection is another option to reduce arc flash. The principle can be explained with the aid of fig 8 which shows differential protection of a bus. Relay class current transformers (CTs) are connected to each external connection to the bus in this case, upstream at the main breaker and downstream of the feeder breakers. The CTs are connected such that if all the currents entering the bus equal all the currents leaving the bus, there is no net current flow into the relay. A bus fault will cause an unbalance of the incoming and outgoing currents and cause the relay to operate. This mechanism is very sensitive to bus faults but immune to load inrushes or pass-through faults. The relay setpoint can be less than the rating of the bus.

Differential relaying protection is applied at medium voltage but is less common at low voltage due to the increased space requirements for relay class CTs, differential protective relays and additional wiring complexity. The costs associated for LV differential relaying protection are also substantial when compared to the cost of the base equipment.

Because of the unique sensing conditions, little if any, intentional delay is required and the fault is cleared. Since arc-flash incident energy varies linearly with clearing time, a faster clearing time can be advantageous. In many cases the source breakers do not have an instantaneous trip function in order to selectively coordinate with the feeders. The differential protection will protect the bus and the source breakers can still selectively coordinate with the feeders. The advantages of differential relaying protection are faster clearing times and improved selectivity.

AFIE TEMPORARY REDUCTION METHODS

Switchable Protective Device Settings



Example System 2 One Line
Figure 9

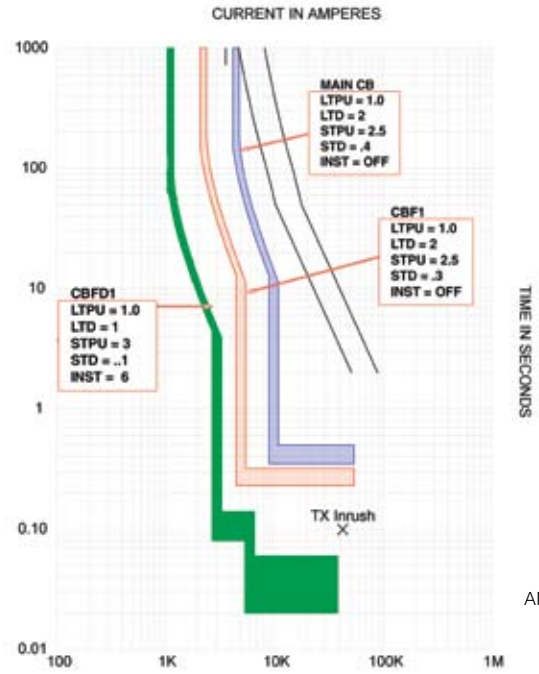
In response to the introduction of Square D® Masterpact circuit breakers with superior arc-flash protection characteristics, some manufacturers have begun to offer alternative schemes based on a temporary compromise of selective coordination during maintenance activities. Square D has developed a method to temporarily reduce the short time delay setting of the breaker by means of an Alternate Maintenance Setting (AMS) switch. This would presumably be for the period in which maintenance is being performed on energized equipment downstream from the main switchgear. A similar method is to reduce the instantaneous trip settings of the upstream breaker feeding this equipment during maintenance. Lowering the instantaneous pick-up setting is functionally equivalent to lowering the short time delay pick-up setting. A further variation for MV arc flash protection is a switchable arc flash setting for the MV protective relay. The relay provides protection and selectivity when the normal settings are active. When the settings are switched to the alternate mode, selectivity may be temporarily sacrificed to achieve reduced incident energy. Finally, some protective devices support an alternate set of trip settings, whereby the trip characteristic can be changed – if desired – to an alternate faster setting during periods of maintenance.

Functionally these options do no more than a maintenance person might do by manually adjusting a breaker's trip setting(s). However, each offers some measure of convenience, especially if multiple set points are to be changed.

In order to quantify the AFIE reduction required to justify the expense of one of these schemes, an arc-flash study must first be performed. Values must be calculated for each of the possible scenarios to determine if any practical difference to maintenance procedures (such as PPE levels) is even possible. For example, if 5 different instantaneous pickup settings are possible, then the study must evaluate all 5 alternate scenarios. In the case of the alternate short time delay setting, only one additional case must be considered. In any case, the study must be completed prior to equipment selection. Of course, this is rarely possible; thus, there is a strong possibility that these options may be purchased and never used.

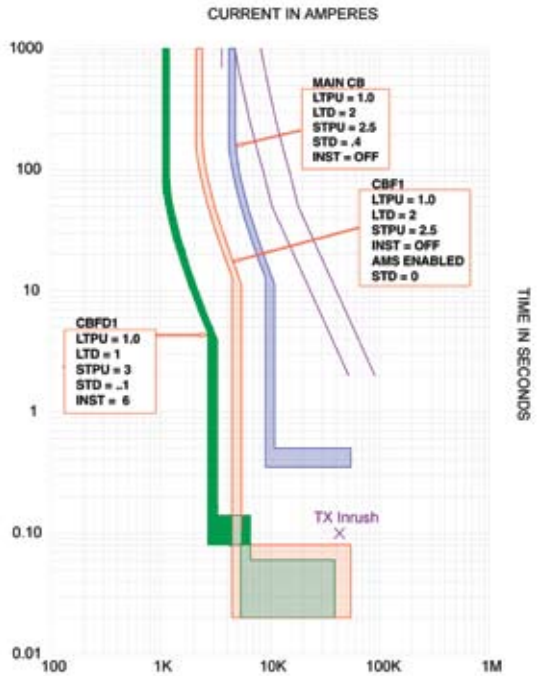
Regardless of which of these methods is employed, it must be understood by the end user that the potential benefits of reduced AFIE are obtained at a cost. These methods introduce new risks which must be evaluated, add a number of new technical, maintenance, and safety (added steps to LOTO procedures) issues which must be addressed.

Ref. Voltage: 480
Current in Amps x 1



Normal Coordination
Figure 10a

Ref. Voltage: 480
Current in Amps x 1



AMS Switch Enabled
Figure 10b

RISKS WITH ALTERNATE TEMPORARY SCHEMES

Sacrificing selective coordination temporarily during maintenance may have its appeal, but like any complex problem, there are many factors to consider. First, the end user must understand the risks:

• **Impact of lost selectivity.** Protective devices are set in accordance with a study for a reason. Compromising selectivity – even temporarily – puts continuity of service at risk. A fault (not just an arc fault) that would have been harmlessly cleared as intended by the nearest upstream protective device now has the potential to interrupt service on a wider scale. This is ironic, since presumably the reason to work on the equipment while energized was to avoid downtime, even if exposing personnel to higher risk.

• **Nuisance trips.** You probably would not ask maintenance personnel to lower the instantaneous pickup setting of a LVPCB while under load, but that is exactly what one manufacturer's maintenance switch does. Unless a study can reliably ensure that the alternate settings are above normal motor inrush currents, etc, there is a risk that the breaker will trip unnecessarily.

• **New hazards.** Even if selectivity can be sacrificed temporarily, the noise and vibration of an unnecessary LVPCB trip could startle workers near the affected switchgear and introduce a new hazard.

• **Possibility that the wrong upstream breaker is switched.** Unlike locking out an open breaker and testing to ensure that the downstream equipment is de-energized, there is no way to verify that the correct upstream breaker has been switched to its alternate settings. An additional burden is shifted to the maintenance procedures to somehow ensure that workers do not make a mistake.

• **False sense of security.** There is a risk that maintenance personnel will be lulled into a false sense of security in the belief that the slight reduction in AFIE levels makes energized equipment safe for work. While it may be possible to reduce the required level of PPE, the electrical hazard remains in effect.

MAINTENANCE AND SAFETY CONSIDERATIONS

In addition, the following maintenance and safety procedure issues must be addressed by the end user or his consultant:

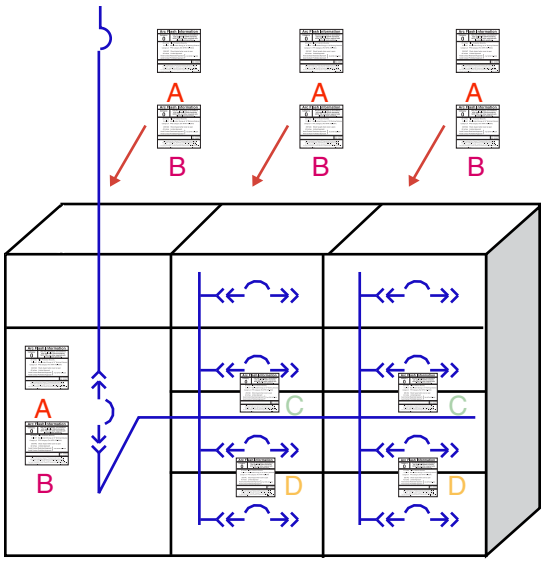
• **Multiple study results.** A second SC/TCC/AF study must be performed to determine the appropriate alternate settings (if indeed it is possible at all). Since there is a possibility that no such alternate characteristics are desirable, this study must be done before the equipment purchase, in order to avoid the purchase of extraneous features.

• **Clear warning signs.** Appropriate warning signs should be provided to maintenance personnel to alert them that switching to alternate settings will override normal selective coordination and increase the possibility of nuisance trips.

• **Increased reliance on procedures.** Maintenance procedures must somehow ensure that personnel working on downstream equipment, while relying on a maintenance switch in upstream switchgear, are sure they have correctly switched the corresponding breaker. In addition, procedures must ensure that the breaker is returned to its normal settings at the conclusion of maintenance activities.

• **Equipment planning.** It may be desirable to locate the maintenance switch for the corresponding breaker nearer to the affected downstream equipment, in order to ensure that no error is made regarding the assumption of upstream protection.

• **Labeling issues.** Introducing a second set of arc-flash calculations introduces new questions about the appropriate labels to alert personnel of the arc flash hazard with the switch in the off or on position. Multiple labels with different AFIE levels may be confusing to maintenance personnel. Additional administrative controls may be required based on the owner's safety practices.



Arc-Flash Labeling is more complicated when alternate schemes are used.
Figure 11

EQUIPMENT CONSIDERATIONS

Square D® PZ4 Switchgear and QED-6 Switchboards are designed, built and tested to comply with industry standards including ANSI and UL Standards (C37.20.1, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear, UL 1558, C37.20.2, IEEE Standard for Metal-clad Switchgear, C37.20.3, IEEE Standard for Metal-Enclosed Interrupter Switchgear and UL 891-Dead Front Switchboards). These standards do not require equipment to be tested for internal arcing faults.

Even with today's enhanced designs of switchgear and switchboards, the use of an AMS Type Switch on a main breaker does not provide the degree of AFIE reduction that may be assumed. There is no guarantee that the arcing fault on the main bus will not propagate ahead of the main breaker in which case, the reduction of AFIE would be dependent upon the upstream device's characteristics.

CONCLUSIONS

A variety of techniques have been introduced to reduce arc-flash incident energy (AFIE) levels. However, selective coordination of overcurrent protective devices is equally important and often misunderstood. The best solution is to use equipment specifically designed for this purpose, which provide superior AFIE reduction without sacrificing selectivity.

At low voltage (600V and below) Square D® Masterpact® low-voltage power circuit breakers offer increased arc-flash protection thanks to faster clearing times, especially at higher current levels. In addition to superior arc-flash protection inherent in their design, Masterpact breakers can be configured in a variety of "Zone Selective Interlocking" (ZSI) schemes to further enhance protection with no impact on selectivity. At higher voltages, Sepam™ overcurrent relays can also be applied in ZSI solutions.

There may be some cases in which these optimal solutions cannot be employed. In such cases, alternative schemes that temporarily sacrifice selectivity may be used, such as the Square D® AMS Switch. However, the risks and technical issues associated with these schemes should be evaluated and understood by the end user or consultant.

In all cases a SC/TCC/AF study must be performed in order to calculate AFIE levels and AF boundaries throughout the power system. Since the study results can be affected by changes in the utility system and changes within the facility, it is recommended that the study be validated each year, or any time significant changes occur. Square D Services can provide a service agreement to ensure continuing arc-flash hazard compliance throughout the life of your facility.

REFERENCES

[1] NFPA 70E, 2004 Standard for Electrical Safety in the Workplace, Quincy, MA: NFPA.
[2] NFPA 70, 2005 National Electrical Code (NEC), Quincy, MA: NFPA.
[3] IEEE Standard 1584-2002, IEEE Guide for Performing Arc-flash Hazard Calculations, New York, NY: IEEE.
[4] Brown, William A. and Ron Shapiro, "A Comparison of Arc-flash Incident Energy Reduction Techniques Using Low-Voltage Power Circuit Breakers," IEEE, 2006.
[5] Weigel, Joseph and Jonathan Clough, "Minimizing the Risk of Arc-flash Incidents," Plant Engineering Magazine, September 2003.
[6] "Arc-flash Protection with Masterpact NW and NT Circuit Breakers, Data Bulletin 0613DB0202R603, Schneider Electric, 2003.

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SQUARE D
by Schneider Electric

Alternate Maintenance Setting (AMS) Switch

Conmutador de ajuste de mantenimiento alternativo (AMS)

Interrupteur de réglage d’entretien alternatif (AMS)

Instruction Bulletin
Boletín de instrucciones
Directives d'utilisation

80298-171-01

Retain for Future Use. /
Conservar para uso futuro. /
À conserver pour usage ultérieur.

SQUARE D
by Schneider Electric

80298-171-01
09/2009
Columbia, SC, USA

Instruction Bulletin

Alternate Maintenance Setting (AMS) Switch

ENGLISH

Retain for future use.

Introduction

Square D® brand Masterpact® circuit breakers, manufactured by Schneider Electric, have superior arc-flash protection characteristics. The Masterpact circuit breakers feature additional arc flash protection when a Short-Time Zone Selective Interlocking (ST-ZSI) scheme is used. When properly applied, the circuit breakers provide reduced arc flash incident energy (AFIE) without changing settings or temporarily compromising the system selective coordination.

For applications where the above solutions are not sufficient, Schneider Electric has developed a method to temporarily reduce the short-time delay setting of the circuit breaker using an alternate maintenance setting (AMS) switch.

In order to quantify the AFIE reduction, an arc-flash analysis must first be performed. Values must be calculated for the possible maintenance setting to determine if any practical changes to maintenance procedures, such as reduction of PPE levels, is even possible.

Safety Precautions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified personnel.
- Perform such work only after reading and understanding all of the instructions contained in this bulletin.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm that the power is off.
- Before performing visual inspections, tests, or maintenance on the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, grounded, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Practice lock-out / tag-out procedures according to OSHA requirements.
- Handle this equipment carefully and install, operate, and maintain it correctly in order for it to function properly. Neglecting fundamental installation and maintenance requirements may lead to personal injury, as well as damage to electrical equipment or other property.
- Carefully inspect your work area and remove any tools and objects left inside the equipment.
- Replace all devices, doors, and covers before turning on power to this equipment.
- All instructions in this manual are written with the assumption that the customer has taken these measures before performing maintenance or testing.

Failure to follow these instructions will result in death or serious injury.

ENGLISH

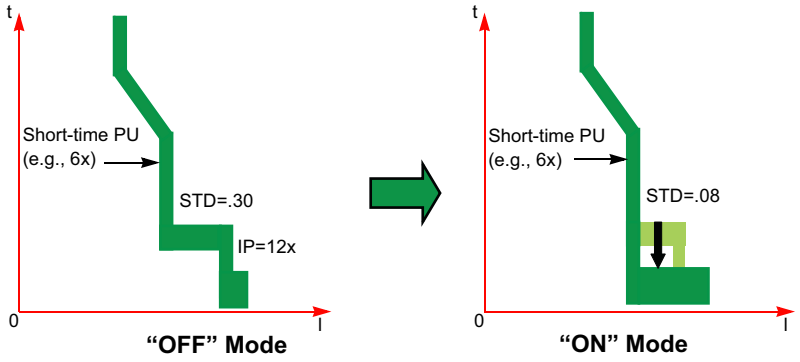
AMS Switch Application

When the AMS Switch is Turned “ON”

The AMS switch can be turned “ON” to reduce circuit breaker tripping time. In the “OFF” mode, a typical short-time delay (STD) setting is 0.3 seconds. The STD setting can be reduced to 0.08 seconds when the switch is in the “ON” mode. See Figure 1.

This is almost equivalent to setting the instantaneous pickup down to the short-time pickup (e.g., instantaneous pickup from 12x to 6x—the difference is that instantaneous maximum clearing time is 0.05 seconds, and unrestrained AMS switch maximum clearing time is 0.08 seconds).

Figure 1: AMS Switch “OFF” and “ON” Mode



For an AMS-controlled breaker to be effective for arc-flash reduction, the breaker’s short-time current pickup setting (considering the positive tolerance) must be set below 85% of the minimum arcing current at the system location where it is expected to provide “fast” interruption (considering all fault current scenarios in an arc flash study).

For example, if a switchgear main circuit breaker is to provide “fast” interruption for an arcing fault in a feeder breaker cell, its short-time current pickup setting (considering the positive tolerance) would need to be set below 85% of the arcing fault current at the switchgear main bus. To ensure coordination, the main and feeder circuit breakers should be coordinated via a time-current coordination analysis (as usual). This application should be documented in the arc flash analysis and safety practices so future breaker adjustments will not result in the arc flash hazard unknowingly increasing for the workers.

Do not use a short-time delay I^2T “ON” breaker trip-unit setting with an AMS switch.

Nuisance Tripping

When the AMS switch is “ON” (breaker is in maintenance mode), the breaker’s short-time delay setting is overridden and the breaker will trip with no intentional delay. As a result, the potential for nuisance tripping increases. Nuisance tripping can be caused by a motor starting, transformer inrush, or some other momentary power disturbance.

Other Considerations

The use of the AMS switch should be integrated into the overall safety policy. Lock-out / tag-out procedures require the use of personal protective equipment (PPE), so adding the necessary steps to ensure the AMS switch is turned to the “ON” position when it should be and turned back to the “OFF” position, as well as using appropriate PPE for each of these modes, are critical for proper application of the AMS switch.

Every AMS switch user must be trained on the proper use of this equipment and how it impacts their safety policy. Additional considerations are as follows:

- Impact of lost selectivity
- Nuisance trips
- Possibility of using wrong AMS switch for desired upstream circuit breaker
- False sense of security
- Increased reliance on procedures
- Equipment planning
- Labeling issues—one reasonable approach is to place arc flash information labels on equipment based on the normal settings mode (which is the AMS switch turned to the “OFF” position) and when using maintenance settings. The user must develop administrative controls based on the user’s safety practices.

NFPA 70B requires proper maintenance of the electrical system. NFPA 70E recommends updating the arc flash study every five years or whenever system modifications are made, such as adjustment of protective device settings.

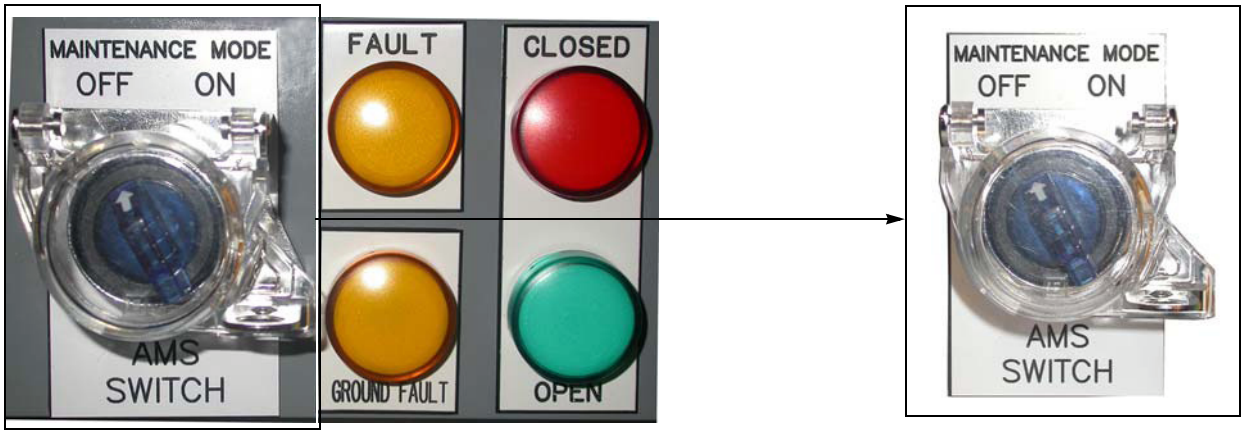
Selecting Maintenance Mode

For the following sections, “Local” refers to the local equipment. “Remote” refers to downstream equipment connected to the local equipment.

Local AMS Switch Option

Locate the AMS switch for the intended circuit breaker (see Figure 2).

Figure 2: Local AMS Switch



1. Turn the AMS switch to the “ON” position. The switch should now illuminate blue, indicating the circuit breaker is in maintenance mode.
2. To return to normal operation, turn the AMS switch to the “OFF” position. The switch should no longer illuminate.

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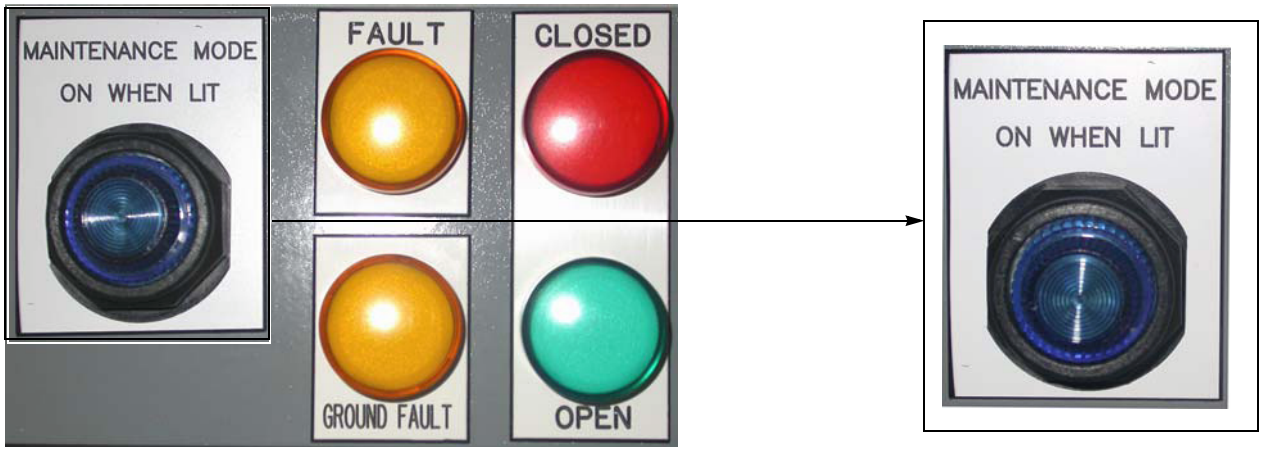
Remote AMS Switch Option

When the remote AMS switch option is ordered, a local maintenance mode indicator light will be placed near the circuit breaker feeding the remote downstream equipment (see Figure 3).

Figure 3: Local Maintenance Mode Indicator Light



1. Locate the user placed remote AMS switch.
2. Turn the remote AMS switch to the “ON” position. The remote switch and the local maintenance mode indicator light near the circuit breaker should both illuminate blue, indicating the circuit breaker is in maintenance mode.
3. To return to normal operation, turn the remote AMS switch to the “OFF” position. The remote switch and the local maintenance mode indicator light (near the circuit breaker) should no longer illuminate.

Testing the AMS System

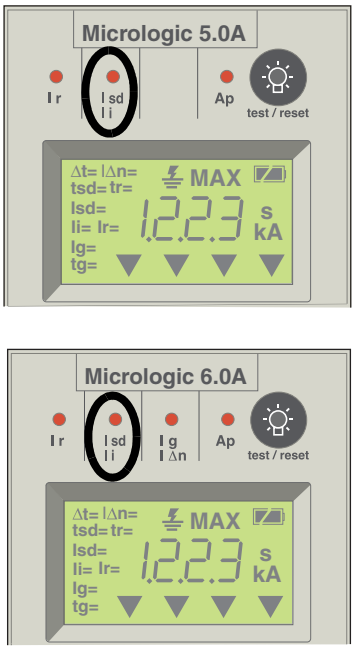
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced by qualified personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm that the power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

Figure 4: Micrologic Circuit Breaker Trip Units—LEDs



The system should be tested upon initial start-up and at regular intervals afterward.

To test the AMS system, follow the steps listed below. Refer to Figure 4 below and Figure 5 on page 6.

1. Verify AMS switch is in the “OFF” position.
2. Locate the restraint interface module (RIM) associated with the AMS switch and circuit breaker to be tested.
   a. Observe the LEDs on the RIM and check that ML-0 In and all six upstream LEDs are lit.
   b. The maintenance mode indicator light on the AMS switch must be off. If using the remote AMS switch option, then the local indicator light must be off as well.
3. Press and hold the AMS switch pushbutton at the bottom of the RIM (terminals 3 and 4). All the LEDs on the RIM must be unlit.
4. While continuing to press the AMS switch pushbutton, press and hold the Push-to-Test button on the RIM, and verify the following:
   a. All six upstream LEDs are lit.
   b. The “Isd” LED at the top of the circuit breaker trip unit will flash on and off in a repeating pattern. See Figure 4.
5. Release both pushbuttons on the RIM.
6. Turn the AMS switch to the “ON” position.
7. The maintenance mode indicator light on the AMS switch must illuminate. If using the remote AMS switch option, then the local maintenance mode indicator light must illuminate as well.
8. Turn the AMS switch to the “OFF” position. The maintenance mode indicator light on the switch must turn off. If using the remote AMS switch option, the local maintenance mode indicator light must turn off as well.
9. Check LEDs and maintenance mode indicator lights(s).
   a. If light(s) function as described, the AMS system is functional.
   b. If light(s) do not function as described, check for problems with items such as power supplies, LEDs, lamps, wiring, etc.

If the problems still persist after checking power supplies, contact your local Schneider Electric sales office.

The above test procedure verifies that the circuit breaker trip unit has received the AMS signal. A complete tripping functionality test must be periodically performed using primary or secondary injection current testing.

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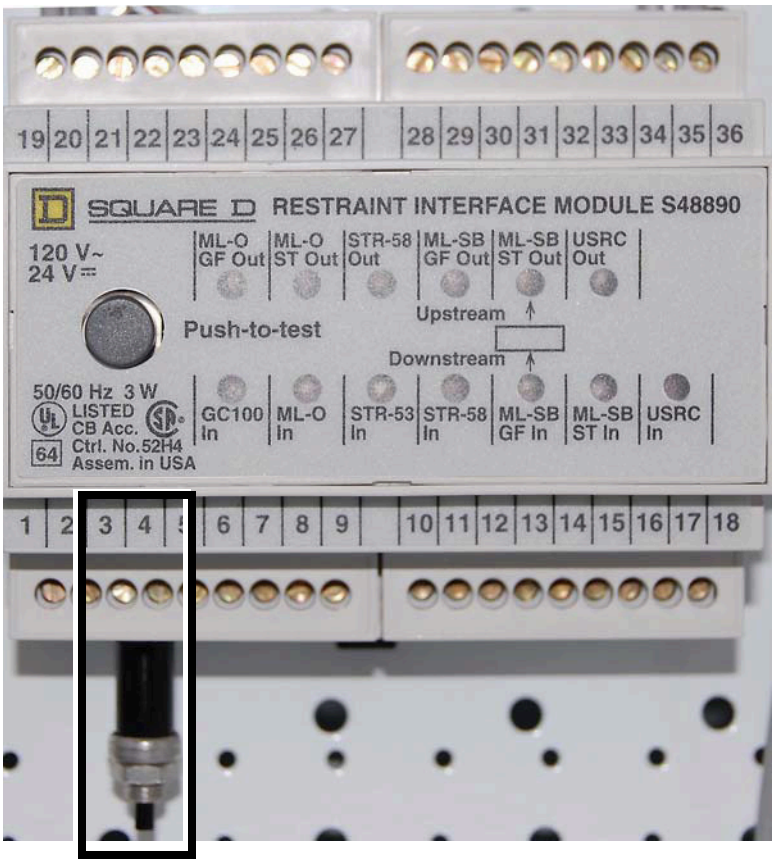
Figure 5: Restraint Interface Module (RIM) and Pushbutton Switch



Remote Options and Mounting Instructions

The standard AMS switch offering is a local lighted switch (see Figure 2 on page 3) located near the circuit breaker. In addition, the user can install a remote maintenance mode indicator wired in parallel to the local maintenance mode indicator. To wire the remote indicator, see Figure 7 on page 8. The dashed lines in the wiring diagram indicates user wiring with 14 AWG wire.

An alternate offering is for the user to install a remote lighted switch assembly at the downstream equipment. See the “Remote AMS Switch Option” in the wiring diagram (see Figure 7 on page 8). With this option, only a local maintenance mode indicator light is provided near the circuit breaker (see Figure 3 on page 4).

Table 1: Parts for Remote AMS Switch Components

Quantity	Catalog Number	Description
1	9001K11J38LLL	Switch with blue indicator light
1	9001KA3	Switch contact block
1	9001K7	Padlock attachment
1	80298-173-01	AMS switch nameplate

The user must provide parts (refer to Table 1) for the remote AMS switch.

The user wires the remote lighted switch to the local equipment with 14 AWG wire as shown with the dashed lines in the wiring diagram (see Figure 7 on page 8). At that time, the factory supplied jumper should be removed as indicated.

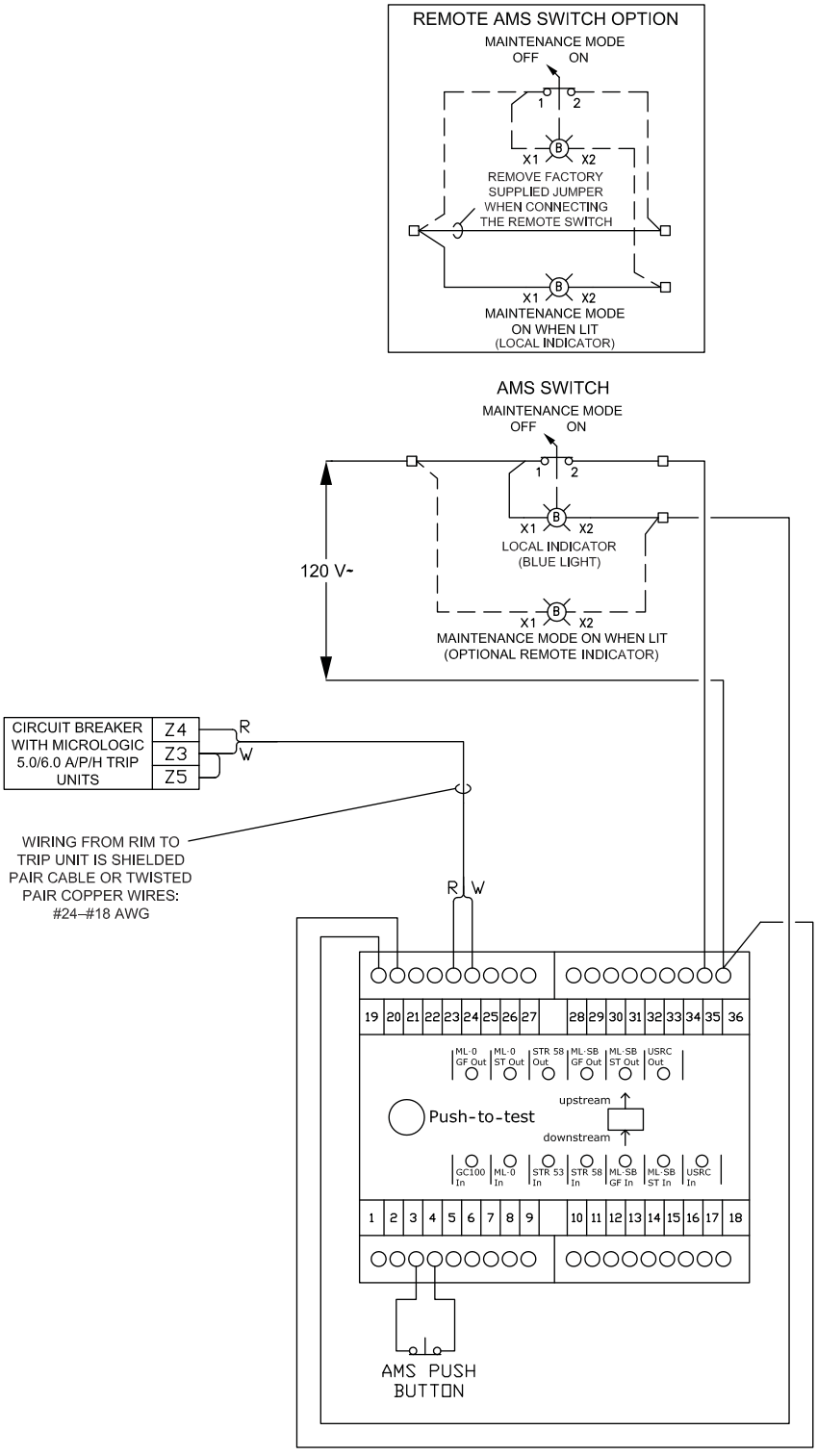
ENGLISH

When the remote AMS switch option is selected, this instruction bulletin includes a label that will need to be applied near the remote AMS switch.

Figure 6: Label for Remote AMS Switch Option

ENGLISH

Figure 7: Wiring Diagram



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80298-171-01
09/2009
Columbia, SC, USA

Boletín de instrucciones

Conmutador de ajuste de mantenimiento alternativo (AMS)

Conservar para uso futuro.

ESPAÑOL

Introducción

Los interruptores de potencia Masterpact® marca Square D® fabricados por Schneider Electric, cuentan con funciones superiores de protección contra destello por arqueo. Los interruptores de potencia Masterpact cuentan con protección adicional contra destello por arqueo cuando se emplea un esquema de enclavamiento selectivo por zona de tiempo corto (ST-ZSI). Cuando se usan correctamente, los interruptores proporcionan energía incidente de destello por arqueo (AFIE) reducida sin modificar los ajustes o comprometer temporalmente el sistema de coordinación selectivo.

En las aplicaciones en que las soluciones anteriores no son suficientes, Schneider Electric ha desarrollado un método para reducir temporalmente el ajuste de retardo de tiempo corto del interruptor empleando un conmutador de ajuste de mantenimiento alternativo (AMS).

Para cuantificar la reducción de AFIE, primero se deberá realizar un análisis de destello por arqueo. Los valores deben ser calculados para obtener el ajuste de mantenimiento posible o poder determinar si una modificación práctica a los procedimientos de mantenimiento, por ejemplo la reducción de los niveles de protección del personal, es feasible.

Precauciones de seguridad

⚠ PELIGRO

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

- Utilice equipo de protección personal (EPP) apropiado y siga las prácticas de seguridad en trabajos eléctricos establecidas por su Compañía, consulte la norma 70E de NFPA y NOM-029-STPS.
- Solamente el personal especializado deberá instalar y prestar servicio de mantenimiento a este equipo.
- Asegúrese de leer y entender todas las instrucciones de este boletín antes de realizar cualquier trabajo en este equipo.
- Desenergice el equipo antes de realizar cualquier trabajo dentro o fuera de él.
- Siempre utilice un dispositivo detector de tensión nominal adecuado para confirmar la desenergización del equipo.
- Antes de realizar una inspección visual, pruebas o servicios de mantenimiento al equipo, desconecte todas las fuentes de alimentación eléctrica. Suponga que todos los circuitos están “vivos” hasta que hayan sido completamente desenergizados, probados, puestos a tierra y etiquetados. Preste particular atención al diseño del sistema de alimentación. Tome en consideración todas las fuentes de alimentación, incluyendo la posibilidad de retroalimentación.
- Siga los procedimientos de bloqueo y etiquetado de acuerdo con los requisitos de OSHA.
- Maneje el equipo con cuidado; instale, haga funcionar y realice servicios de mantenimiento adecuadamente para que funcione como es debido. El incumplimiento de los requisitos fundamentales de instalación y servicios de mantenimiento puede causar lesiones personales así como daño al equipo eléctrico u otros bienes.
- Inspeccione detenidamente el área de trabajo y retire las herramientas u objetos que hayan quedado dentro del equipo.
- Vuelva a colocar todos los dispositivos, las puertas y las cubiertas antes de energizar este equipo.
- Todas las instrucciones de este manual fueron escritas suponiendo que el cliente ha adoptado estas medidas de precaución antes de prestar servicios de mantenimiento o realizar una prueba.

El incumplimiento de estas instrucciones podrá causar la muerte o lesiones serias.

ESPAÑOL

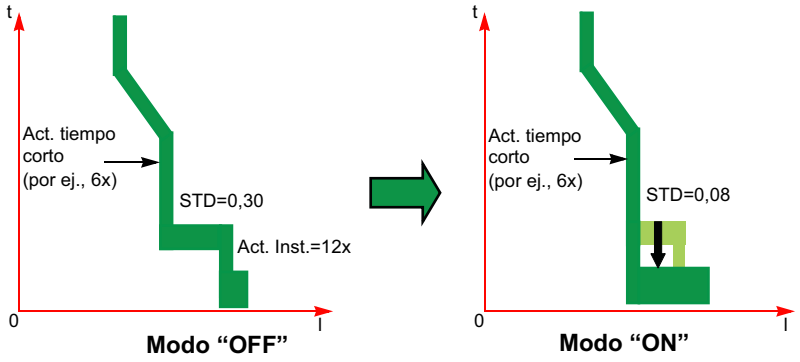
Uso del conmutador AMS

Cuando el conmutador AMS se encuentra en el modo “ON”

El conmutador AMS puede colocarse en el modo “ON” para reducir el tiempo de disparo del interruptor. En el modo “OFF”, un ajuste típico de retardo de tiempo corto (STD) es de 0,3 segundo. El ajuste STD puede ser reducido en 0,08 segundo cuando el conmutador se encuentra en el modo de “ON”. Vea la figura 1.

Esto es casi equivalente a la reducción del ajuste de activación instantánea en el ajuste de activación de tiempo corto (por ejemplo, la activación instantánea de 12x a 6x—la diferencia es que el tiempo máximo de activación instantánea es de 0,05 segundo y el tiempo máximo de activación del conmutador AMS no restringido es de 0,08 segundo).

Figura 1: Conmutador AMS en el modo “OFF” y “ON”



Para que un interruptor controlado por un conmutador AMS sea eficaz en la reducción de destello por arqueo, el ajuste de activación de la corriente de tiempo corto del interruptor (tomando en consideración la tolerancia positiva) deberá tener un valor por debajo del 85% de la corriente mínima de arqueo en la ubicación del sistema donde se espera que éste proporcione la interrupción “rápida” (teniendo en cuenta todos los métodos de corriente de falla en un estudio de destello por arqueo).

Por ejemplo, si un interruptor automático principal de un tablero de fuerza debe proporcionar interrupción “rápida” para una falla de arqueo en una celda de un interruptor alimentador, su ajuste de activación de la corriente de tiempo corto (teniendo en cuenta la tolerancia positiva) necesitará un valor por debajo del 85% de la corriente de falla de arqueo en la barra principal del tablero de fuerza. Para garantizar la coordinación, los interruptores automáticos principal y alimentador deberán ser coordinados a través de un análisis de coordinación tiempo-corriente (como es común). Esta aplicación deberá documentarse en el análisis de destello por arqueo y prácticas de seguridad para que ajustes futuros del interruptor no resulten en un riesgo inconsciente de destello por arqueo cada vez mayor para los trabajadores.

No utilice un ajuste de retardo de tiempo corto I^2T “ON” en la unidad de disparo del interruptor con un conmutador AMS.

Disparo involuntario

Cuando el conmutador AMS está en modo “ON” (el interruptor se encuentra en modo de mantenimiento), el ajuste de retardo de tiempo corto del interruptor automático es ignorado y el interruptor se disparará sin retardo intencional. Por consiguiente, la posibilidad de que se produzca un disparo involuntario aumenta. Los disparos involuntarios pueden ser causados por un arranque de motor, irrupción de un transformador o cualquier otra distorsión de alimentación momentánea.

Otros factores

El uso de un conmutador AMS debe ser integrado en los procedimientos de seguridad generales. Los procedimientos de bloqueo y etiquetado requieren el uso de equipo de protección personal (EPP); por lo tanto, la realización de los pasos necesarios para asegurarse de que el conmutador AMS esté en el modo “ON” cuando debe estar y que regrese al modo “OFF”, así como el uso del EPP apropiado para cada uno de estos modo, son críticos para el uso apropiado del conmutador.

Cada usuario del conmutador AMS debe ser capacitado en el uso correcto de este equipo y la manera en que éste puede afectar los procedimientos de seguridad. Otros factores que deben considerarse son:

- Impacto de selectividad perdida
- Disparos involuntarios
- Posibilidad de usar un conmutador AMS incorrecto para el interruptor automático de corriente ascendente deseado.
- Falsa sensación de seguridad
- Confianza cada vez mayor en los procedimientos
- Planeación del equipo
- Etiquetado—un método práctico es colocar las etiquetas de información de destello por arqueo en el equipo cuando está en el modo de ajustes normales (que es el conmutador AMS en el modo “OFF”) y cuando se usan los ajustes de mantenimiento. El usuario debe desarrollar controles administrativos en base a las prácticas de seguridad.

La norma 70B de NFPA requiere de un mantenimiento apropiado del sistema eléctrico. Esta norma recomienda actualizar el estudio de destello por arqueo cada cinco años o cada vez que se realizan modificaciones al sistema, por ejemplo ajustes a los valores de protección del dispositivo.

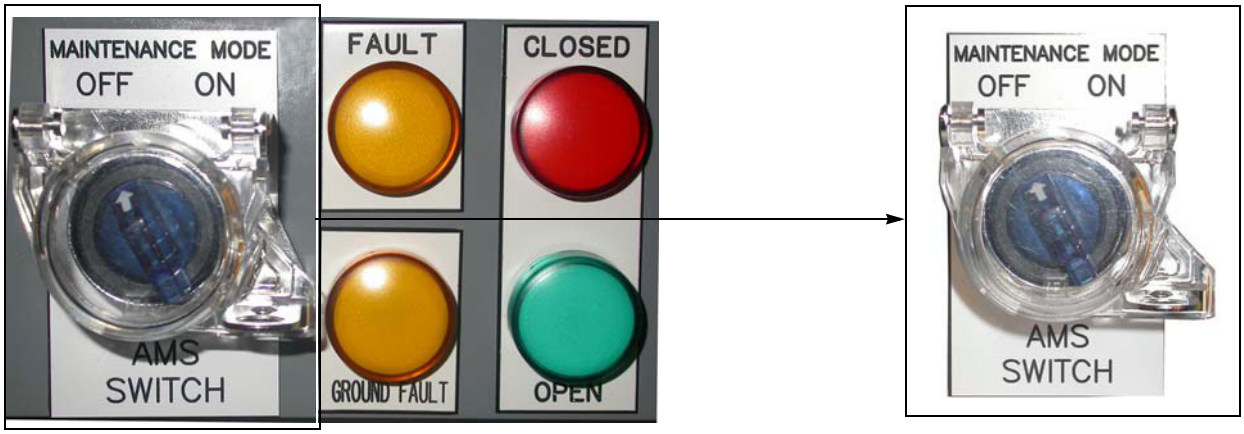
Cómo seleccionar el modo de mantenimiento

Para las siguientes secciones, “Local” se refiere al equipo local. “Remoto” se refiere al equipo de corriente descendente conectado al equipo local.

Opción del conmutador ASM local

Localice el conmutador AMS para el interruptor automático deseado (figura 2).

Figura 2: Conmutador AMS local

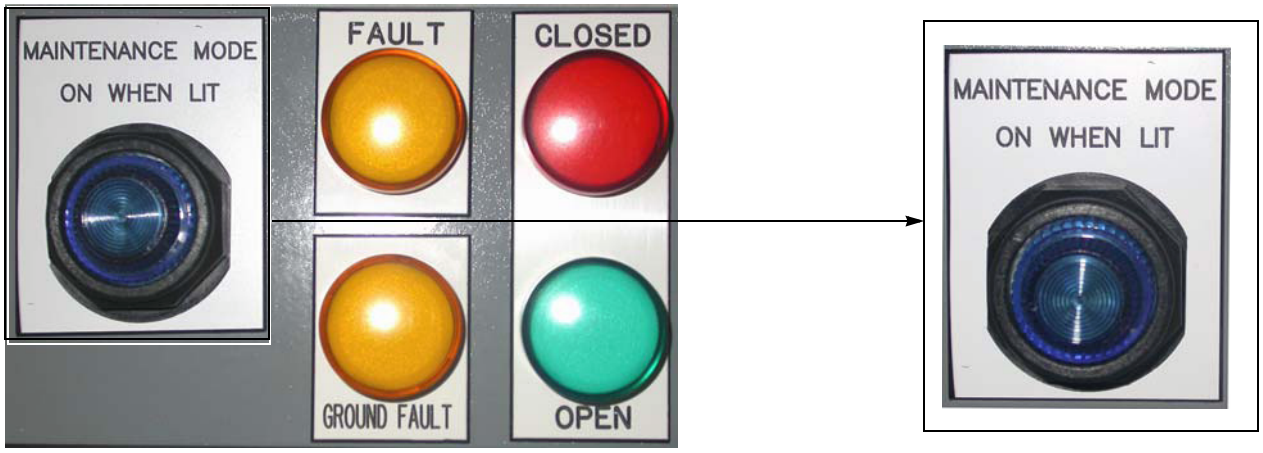


1. Coloque el conmutador AMS en el modo “ON”. El conmutador ahora deberá estar iluminado en azul, lo cual indica que el interruptor automático se encuentra en el modo de mantenimiento.
2. Para regresar al funcionamiento normal, coloque el conmutador AMS en el modo “OFF”. El conmutador ya no deberá estar iluminado.

Opción del conmutador AMS remoto

Cuando se solicita la opción de conmutador AMS remoto, una luz indicadora de modo de mantenimiento local se colocará junto al interruptor automático que alimenta al equipo de corriente descendente remoto (vea la figura 3).

Figura 3: Luz indicadora de modo de mantenimiento local



1. Localice el conmutador AMS remoto colocado por el usuario.
2. Coloque el conmutador AMS remoto en el modo “ON”. El conmutador remoto y la luz indicadora de modo de mantenimiento local (junto al interruptor automático) deberán iluminarse en azul, lo cual indica que el interruptor se encuentra en modo de mantenimiento.
3. Para regresar al funcionamiento normal, coloque el conmutador AMS remoto en el modo “OFF”. El interruptor remoto y la luz indicadora de modo de mantenimiento local (junto al interruptor automático) ya no deberán estar iluminadas.

Prueba del sistema AMS

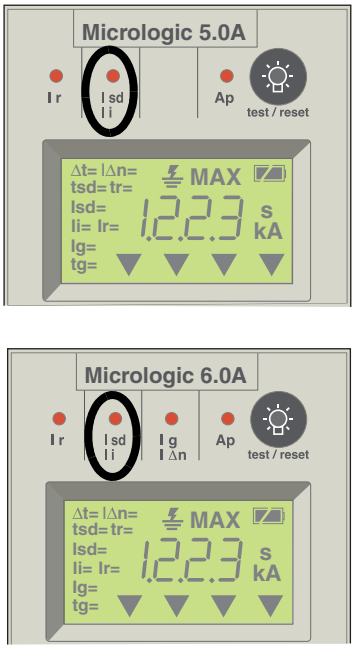
⚠ PELIGRO

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

- Utilice equipo de protección personal (EPP) apropiado y siga las prácticas de seguridad en trabajos eléctricos establecidas por su Compañía, consulte la norma 70E de NFPA y NOM-029-STPS.
- Solamente el personal especializado deberá instalar y prestar servicio de mantenimiento a este equipo.
- Desenergice el equipo antes de realizar cualquier trabajo dentro o fuera de él.
- Siempre utilice un dispositivo detector de tensión nominal adecuado para confirmar la desenergización del equipo.
- Vuelva a colocar todos los dispositivos, las puertas y las cubiertas antes de energizar este equipo.

El incumplimiento de estas instrucciones podrá causar la muerte o lesiones serias.

Figura 4: LED de la unidad de disparo Micrologic LED del interruptor automático



El sistema deberá probarse durante el arranque inicial y en intervalos regulares posteriormente.

Para probar el sistema AMS, siga los siguientes pasos. Consulte la figura 4 abajo y la figura 5 en la página 6.

1. Asegúrese de que el conmutador AMS se encuentre en el modo “OFF”.
2. Localice el módulo de interfaz retardador (MIR) relacionado con el conmutador AMS y el interruptor automático que va a ser probado.
   a. Observe los indicadores LED en el MIR y asegúrese de que la entrada “ML-O In” y los seis LED de corriente ascendente estén iluminados.
   b. La luz indicadora de modo de mantenimiento en el conmutador AMS debe estar apagada. Si se va a usar la opción de conmutador AMS remoto, entonces la luz indicadora local también debe estar apagada.
3. Oprima y mantenga oprimido el botón del conmutador AMS en la parte inferior del MIR (terminales 3 y 4). Todos los LED en el MIR deben estar apagados.
4. Mientras continúa oprimiendo el botón del conmutador AMS, oprima y mantenga oprimido el botón de prueba en el MIR, verifique que:
   a. todos los seis LED de corriente ascendente estén iluminados.
   b. el LED “Isd” en la parte superior de la unidad de disparo del interruptor automático destelle en un patrón repetido. Vea la figura 4.
5. Suelte ambos botones en el MIR.
6. Coloque el conmutador AMS en el modo “ON”.
7. La luz indicadora de modo de mantenimiento en el conmutador AMS debe estar iluminada. Si se va a usar la opción de conmutador AMS remoto, entonces la luz indicadora de modo de mantenimiento local también debe estar iluminada.
8. Coloque el conmutador AMS en el modo “OFF”. La luz indicadora de modo de mantenimiento en el conmutador AMS debe estar apagada. Si se va a usar la opción de conmutador AMS remoto, entonces la luz indicadora de modo de mantenimiento local también debe estar apagada.
9. Revise los LED y las luces indicadoras de modo de mantenimiento.
   a. Si las luces funcionan como es debido, el sistema AMS está funcionando correctamente.
   b. Si las luces no funcionan como es debido, revise las fuentes de alimentación, los LED, lámparas, cables, etc. para ver si encuentra algún problema.

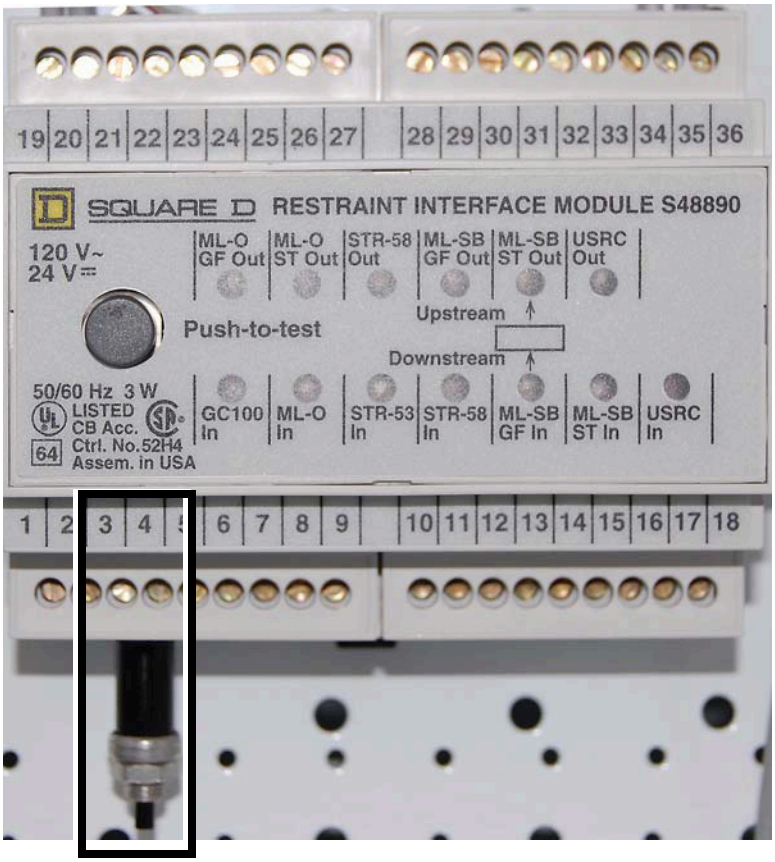
Si persisten los problemas después de haber revisado las fuentes de alimentación, comuníquese con la oficina local de ventas de Schneider Electric.

El procedimiento de prueba anterior verifica que la unidad de disparo del interruptor automático haya recibido la señal del AMS. Una prueba de funcionalidad completa de disparo deberá realizarse periódicamente usando pruebas de corriente de inyección primaria y secundaria.

ESPAÑOL

ESPAÑOL

Figura 5: Módulo de interfaz retardador (MIR) y el botón del conmutador



Opciones remotas e instrucciones de montaje

El conmutador AMS estándar es un conmutador iluminado local (vea la figura 2 en la página 3) situado junto al interruptor automático. Además, es posible instalar un indicador de modo de mantenimiento remoto conectado en paralelo al indicador de modo de mantenimiento local. Para conectar el indicador remoto, vea la figura 7 en la página 8. Las líneas punteadas en el diagrama de alambrado indican el alambrado del usuario concable de tamaño 2,08 mm^2 (14 AWG).

Table 1: Piezas para los componentes del conmutador AMS remoto

Cant.	No. de cat.	Descripción
1	9001K11J38LLL	Conmutador con luz indicadora azul
1	9001KA3	Bloque de contactos del conmutador
1	9001K7	Aditamento de candado
1	80298-173-01	Placa de datos del conmutador AMS

Otra opción es instalar un ensamble de conmutador iluminado remoto en el equipo de corriente descendente. Consulte “Opción de conmutador AMS remoto” en el diagrama de alambrado (vea la figura 7 en la página 8). Con esta opción, únicamente una luz indicadora de modo de mantenimiento local es provista junto al interruptor automático (vea la figura 3 en la página 4).

El usuario debe proporcionar las piezas (consulte la tabla 1) para el conmutador AMS remoto.

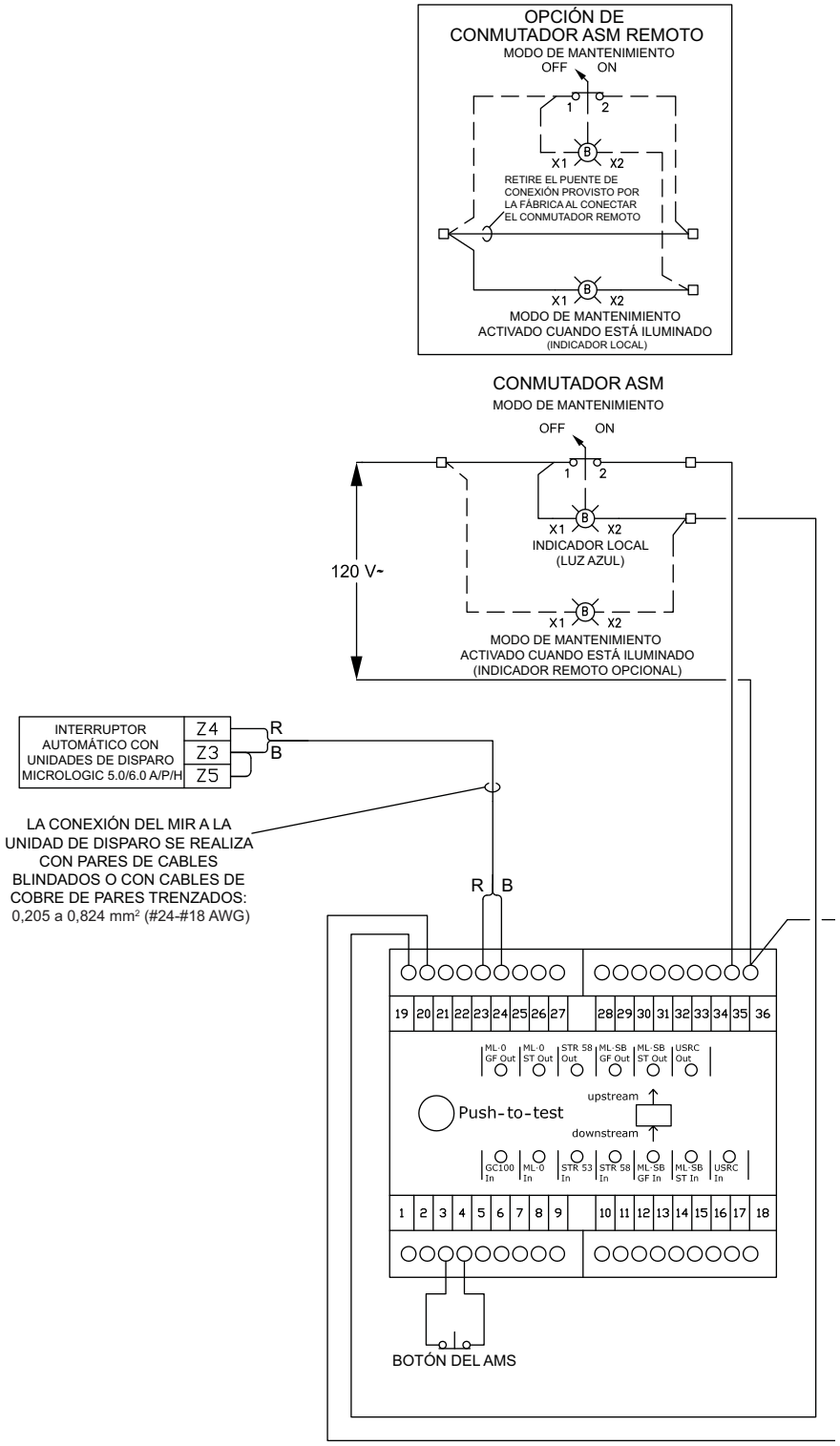
El usuario es responsible de conectar el conmutador iluminado remoto en el equipo local con cable de 2,08 mm^2 (14 AWG) como se muestra con las líneas punteadas en el diagrama de alambrado (vea la figura 7 en la página 8.). En este momento, el puente de conexión provisto por la fábrica deberá retirarse como se indica.

Cuando se selecciona la opción de conmutador AMS remoto, este boletín de instrucciones incluye una etiqueta que necesita ser colocada junto al conmutador AMS remoto.

Figura 6: Etiqueta para la opción de conmutador AMS remoto

ESPAÑOL

Figura 7: Diagrama de alambrado



Importado en México por:
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www.schneider-electric.com.mx

80298-171-01
09/2009
Columbia, SC, É.-U.

Directives d'utilisation

Interrupteur de réglage d'entretien alternatif (AMS)

À conserver pour usage ultérieur.

Introduction

Les disjoncteurs Masterpact® de la marque Square D®, fabriqués par Schneider Electric, ont des caractéristiques de protection contre les éclairs d'arc supérieures. Les disjoncteurs Masterpact présentent une protection contre les éclairs d'arc supplémentaire lorsqu'un dispositif d'interverrouillage sélectif de zone à temps court (ST-ZSI) est utilisé. Quand ils sont utilisés correctement, les disjoncteurs fournissent une énergie incidente d'éclair d'arc (AFIE) réduite sans modifier les réglages ni compromettre temporairement la coordination sélective du système.

Pour les applications pour lesquelles les solutions ci-dessus ne sont pas suffisantes, Schneider Electric a développé une méthode pour réduire temporairement le réglage de retard à temps court du disjoncteur à l'aide d'un interrupteur de réglage d'entretien alternatif (AMS).

Pour déterminer l'importance de la réduction de l'énergie incidente d'éclair d'arc (AFIE), une analyse d'éclair d'arc doit tout d'abord être effectuée. Les valeurs doivent être calculées pour déterminer le réglage d'entretien possible si des changements d'ordre pratique aux procédures d'entretien, comme une réduction des niveaux d'équipement de protection personnelle (ÉPP), sont même possibles.

FRANÇAIS

Mesures de sécurité

⚠ DANGER

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

- Portez un équipement de protection personnelle (ÉPP) approprié et observez les méthodes de travail électrique sécuritaire. Voir NFPA 70E.
- Seul un personnel qualifié doit effectuer l'installation et l'entretien de cet appareil.
- N'entreprenez ce travail qu'après avoir lu et compris toutes les explications contenues dans ces directives.
- Coupez toutes les alimentations de l'appareil avant d'y travailler.
- Utilisez toujours un dispositif de détection de tension à valeur nominale appropriée pour vous assurer que l'alimentation est coupée.
- Avant d'effectuer des inspections visuelles, des essais ou des procédures d'entretien sur cet appareil, déconnectez toutes les sources d'alimentation. Présumez que tous les circuits sont sous tension tant qu'ils n'ont pas été complètement mis hors tension, vérifiés, mis à la terre et étiquetés. Faites particulièrement attention à l'agencement du système d'alimentation. Considérez toutes les sources d'alimentation, y compris la possibilité de rétro-alimentation.
- Observez toutes les procédures d'interverrouillage et d'étiquetage selon la réglementation OSHA.
- Traitez cet appareil avec soin et installez-le, utilisez-le et entretenez-le correctement pour assurer son bon fonctionnement. Le non-respect des exigences fondamentales d'installation et d'entretien peut entraîner des blessures, ainsi que des dommages à l'équipement électrique ou autres biens.
- Inspectez soigneusement la zone de travail et enlevez tous les outils et objets laissés à l'intérieur de l'appareil.
- Replacez tous les dispositifs, les portes et les couvercles avant de mettre l'appareil sous tension.
- Les explications données dans ces directives présument que le client a pris ces mesures avant d'effectuer un entretien ou des essais.

Si ces directives ne sont pas respectées, cela entraînera la mort ou des blessures graves.

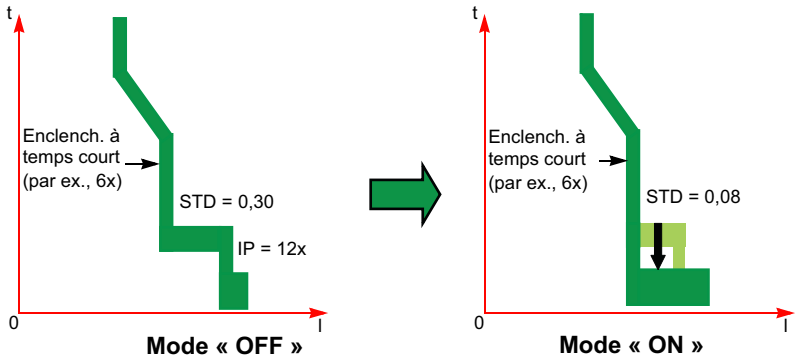
Application d'un interrupteur AMS

Quand l'interrupteur AMS est dans le mode ON (marche)

L'interrupteur AMS peut être mis en mode ON pour réduire le temps de déclenchement du disjoncteur. En mode OFF (arrêt), un réglage typique de retard à temps court (STD) est de 0,3 seconde. Le réglage STD peut être réduit à 0,08 seconde quand l'interrupteur est en mode ON. Voir la figure 1.

Cela est presque équivalent à un réglage de l'enclenchement instantané (IP) réduit à l'enclenchement à temps court (par ex., enclenchement instantané de 12x à 6x—la différence est que le temps maximum de désactivation instantané est de 0,5 seconde et que le temps maximum de désactivation non restreint de l'interrupteur AMS est de 0,08 seconde).

Figure 1 : Interrupteur AMS en mode « OFF » et « ON »



Pour qu'un disjoncteur contrôlé par un interrupteur AMS puisse réduire les éclairs d'arc efficacement, le réglage de l'enclenchement de courant à temps court du disjoncteur (en tenant compte de la tolérance positive) doit être inférieur à 85 % du courant d'arc minimum à l'emplacement du système où il est censé fournir une interruption « rapide » (en considérant tous les scénarios de courant de défaut dans une étude d'éclair d'arc).

Par exemple, si un disjoncteur principal d'appareillage de commutation doit fournir une interruption « rapide » pour un défaut d'arc dans une cellule de disjoncteur d'alimentation, son réglage d'enclenchement de courant à temps court (en tenant compte de la tolérance positive) devrait être inférieur à 85 % du courant de défaut d'arc à la barre-bus principale de l'appareillage de commutation. Pour assurer la coordination, le disjoncteur principal et le disjoncteur d'alimentation doivent être coordonnés au moyen d'une analyse de coordination temps-courant (comme d'habitude). Cette application devrait être documentée dans l'analyse d'éclair d'arc et les mesures de sécurité de façon à ce que les réglages futurs des disjoncteurs n'entraînent pas une augmentation involontaire des risques d'éclairs d'arc pour les utilisateurs.

Ne pas utiliser un réglage de retard à temps court I^2T « ON » pour un déclencheur de disjoncteur avec un interrupteur AMS.

Déclenchement intempestif

Quand l'interrupteur AMS est en mode « ON » (le disjoncteur est en mode d'entretien), le réglage de retard à temps court du disjoncteur est supplanté et le disjoncteur se déclenchera sans retard intentionnel. Par suite, la possibilité de déclenchement intempestif augmente. Un déclenchement intempestif peut être causé par le démarrage d'un moteur, un appel de transformateur ou toute autre perturbation momentanée de l'alimentation.

Autres considérations

L'utilisation de l'interrupteur AMS devrait être incorporée dans la politique de sécurité générale. Les procédures de verrouillage/d'étiquetage nécessitent l'emploi d'un équipement de protection personnelle (ÉPP); l'ajout de points nécessaires pour assurer que l'interrupteur AMS est mis en mode « ON » quand il le faut et ensuite remis en mode « OFF » et l'emploi d'un ÉPP approprié pour chacun de ces modes, sont essentiels pour l'utilisation adéquate de l'interrupteur AMS.

Chaque utilisateur d'interrupteur AMS doit recevoir une formation sur l'utilisation correcte de cet appareil et son impact sur la politique de sécurité qui le concerne. Autres considérations :

- Impact de sélectivité perdue
- Déclenchements intempestifs
- Possibilité d'utilisation du mauvais interrupteur AMS pour un disjoncteur en amont désiré
- Fausse impression de sécurité
- Accroissement de la dépendance des procédures
- Planification des appareils
- Points d'étiquetage—une approche pratique est de placer des étiquettes d'informations d'éclairs d'arc sur l'appareil, basées sur les modes de réglages normaux (à savoir, l'interrupteur AMS mis en mode « OFF ») et lors de l'utilisation des réglages d'entretien. L'utilisateur doit développer des contrôles d'emploi basés sur les mesures de sécurité.

La norme NFPA 70B exige un entretien approprié du système électrique. La norme NFPA 70E recommande la mise à jour de l'étude des éclairs d'arc tous les cinq ans ou à chaque fois que des modifications sont apportées au système, comme l'ajustement des réglages des dispositifs de protection.

FRANÇAIS

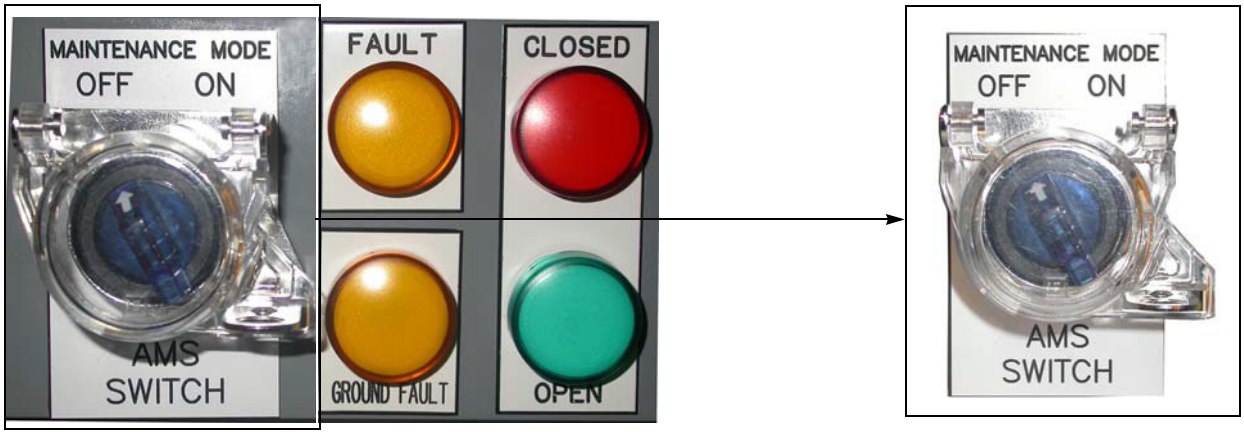
Sélection du mode d'entretien

Pour les sections suivantes, « local » concerne l'appareil local. « À distance » concerne l'appareil en aval raccordé à l'appareil local.

Option d'interrupteur AMS local

Localiser l'interrupteur AMS pour le disjoncteur voulu (voir la figure 2).

Figure 2 : Interrupteur AMS local

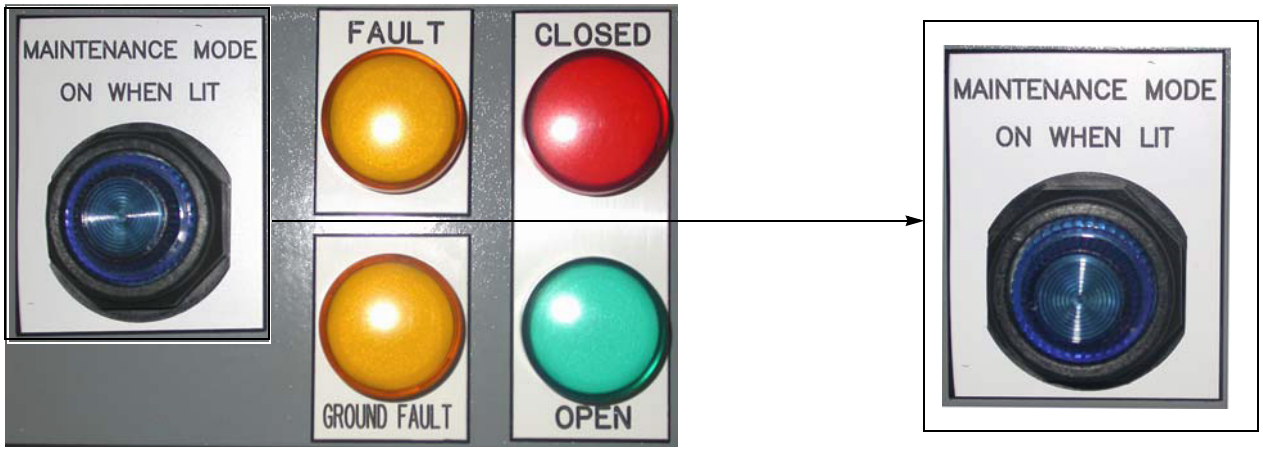


1. Mettre l'interrupteur AMS en mode « ON ». L'interrupteur doit être maintenant allumé bleu, indiquant que le disjoncteur est en mode d'entretien.
2. Pour retourner en fonctionnement normal, mettre l'interrupteur AMS en mode « OFF ». L'interrupteur ne doit plus être allumé.

Option d'interrupteur AMS à distance

Quand l'option d'interrupteur AMS à distance est commandée, un voyant de mode d'entretien local sera placé près du disjoncteur qui alimente l'appareil à distance en aval (voir la figure 3).

Figure 3 : Voyant du mode d'entretien



1. Localiser l'interrupteur AMS à distance placé par l'utilisateur.
2. Mettre l'interrupteur AMS à distance en mode « ON ». L'interrupteur à distance et le voyant de mode d'entretien local près du disjoncteur doivent être allumés en bleu tous les deux, indiquant que le disjoncteur est en mode d'entretien.
3. Pour retourner en fonctionnement normal, mettre l'interrupteur AMS à distance en mode « OFF ». L'interrupteur à distance et le voyant de mode d'entretien local (près du disjoncteur) ne devraient plus être allumés.

FRANÇAIS

Essai du système AMS

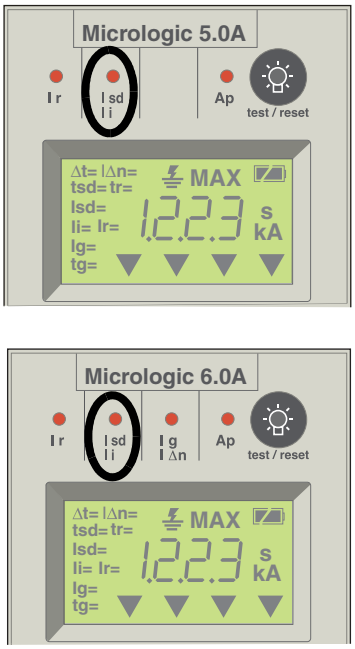
⚠ DANGER

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

- Portez un équipement de protection personnelle (ÉPP) approprié et observez les méthodes de travail électrique sécuritaire. Voir NFPA 70E.
- Seul un personnel qualifié doit effectuer l'installation et l'entretien de cet appareil.
- Coupez toutes les alimentations de l'appareil avant d'y travailler.
- Utilisez toujours un dispositif de détection de tension à valeur nominale appropriée pour vous assurer que l'alimentation est coupée.
- Replacez tous les dispositifs, les portes et les couvercles avant de mettre l'appareil sous tension.

Si ces directives ne sont pas respectées, cela entraînera la mort ou des blessures graves.

Figure 4 : DÉL du déclencheur Micrologic du disjoncteur



Le système doit être essayé au moment de sa mise en service initiale et ensuite à intervalles réguliers.

Pour essayer le système AMS, suivre les points indiqués ci-dessous. Se reporter à la figure 4 ci-après et à la figure 5 à la page 6.

1. S'assurer que l'interrupteur AMS se trouve en mode « OFF ».
2. Localiser le module d'interface retardateur (RIM) associé à l'interrupteur AMS et au disjoncteur à essayer.
   a. Observer les DÉL sur le RIM et s'assurer que le voyant de l'entrée « ML-O In » et les six DÉL en amont (upstream) sont allumés.
   b. Le voyant de mode d'entretien sur l'interrupteur AMS doit être éteint. En cas d'utilisation de l'option d'interrupteur AMS à distance, le voyant local doit être aussi éteint.
3. Appuyer sur le bouton-poussoir de l'interrupteur AMS au bas du RIM et le maintenir enfoncé (bornes 3 et 4). Toutes les DÉL sur le RIM doivent être éteintes.
4. Tout en maintenant le bouton-poussoir de l'interrupteur AMS enfoncé, appuyer sur le bouton « Push-to-Test » (pousser-pour-vérifier) sur le RIM et le maintenir enfoncé. puis vérifier ce qui suit :
   a. Les six DÉL en amont sont allumées.
   b. La DÉL « Isd » au haut du déclencheur du disjoncteur clignotera d'une façon répétée. Voir la figure 4.
5. Relâcher les deux boutons-poussoirs sur RIM.
6. Mettre l'interrupteur AMS en mode « ON ».
7. Le voyant du mode d'entretien sur l'interrupteur AMS doit s'allumer. En cas d'utilisation de l'option d'interrupteur AMS à distance, le voyant de mode d'entretien local doit être aussi allumé.
8. Mettre l'interrupteur AMS en mode « OFF ». Le voyant de mode d'entretien sur l'interrupteur doit s'éteindre. En cas d'utilisation de l'option d'interrupteur AMS à distance, le voyant de mode d'entretien local doit aussi s'éteindre.
9. Vérifier les DÉL et les voyants de mode d'entretien.
   a. Si les voyants fonctionnent comme décrit, le système AMS est fonctionnel.
   b. Si des voyants ne fonctionnent pas comme décrit, rechercher les problèmes dans les blocs d'alimentation, DÉL, lampes, câblages, etc.

Si les problèmes persistent encore après avoir vérifié les blocs d'alimentation, contacter le bureau des ventes local de Schneider Electric.

La procédure d'essai ci-dessus vérifie que le déclencheur du disjoncteur a reçu le signal de l'AMS. Un essai de fonctionnalité de déclenchement complet doit être effectué périodiquement au moyen d'un essai d'injection de courant primaire ou secondaire.

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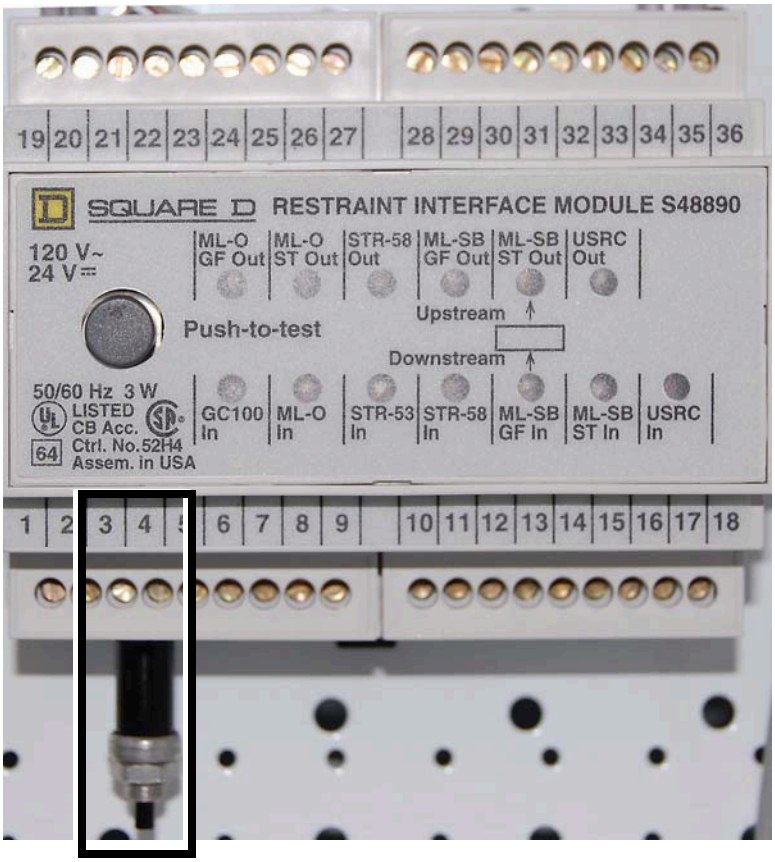
Figure 5 : Module d'interface retardateur (RIM) et bouton-poussoir de l'interrupteur



Options à distance et instructions de montage

L'interrupteur AMS standard est un interrupteur lumineux local (voir la figure 2 à la page 3) situé près du disjoncteur. De plus, l'utilisateur peut installer un voyant de mode d'entretien à distance câblé en parallèle au voyant de mode d'entretien local. Pour câbler le voyant à distance, voir la figure 7 à la page 8. Les lignes pointillées sur le schéma de câblage indiquent un câblage de l'utilisateur avec du fil de calibre 14 AWG.

Une autre option est d'installer un assemblage d'interrupteur lumineux à distance au niveau de l'appareil en aval. Voir « Option d'interrupteur AMS à distance » sur le schéma de câblage (voir la figure 7 à la page 8). Avec cette option, seul un voyant de mode d'entretien local est fourni près du disjoncteur (voir la figure 3 à la page 4).

Tableau 1 : Pièces pour les composants de l'interrupteur AMS à distance

Qté	N° de catalogue	Description
1	9001K11J38LLL	Interrupteur avec voyant bleu
1	9001KA3	Bloc à contacts de l'interrupteur
1	9001K7	Accessoire de cadenassage
1	80298-173-01	Plaque signalétique de l'interrupteur AMS

L'utilisateur doit fournir les pièces (consulter le Table 1) pour l'interrupteur AMS à distance.

L'utilisateur doit câblé l'interrupteur lumineux à distance à l'appareil local avec du fil de calibre 14 AWG comme indiqué par les lignes pointillées du schéma de câblage (voir la figure 7 à la page 8). À ce moment, le cavalier fourni par l'usine doit être enlevé comme indiqué.

Lorsque l'option d'interrupteur AMS à distance est choisie, ces directives d'utilisation comprennent une étiquette qui devra être placée près de l'interrupteur AMS à distance.

Figure 6 : Étiquette pour l'option d'interrupteur AMS à distance

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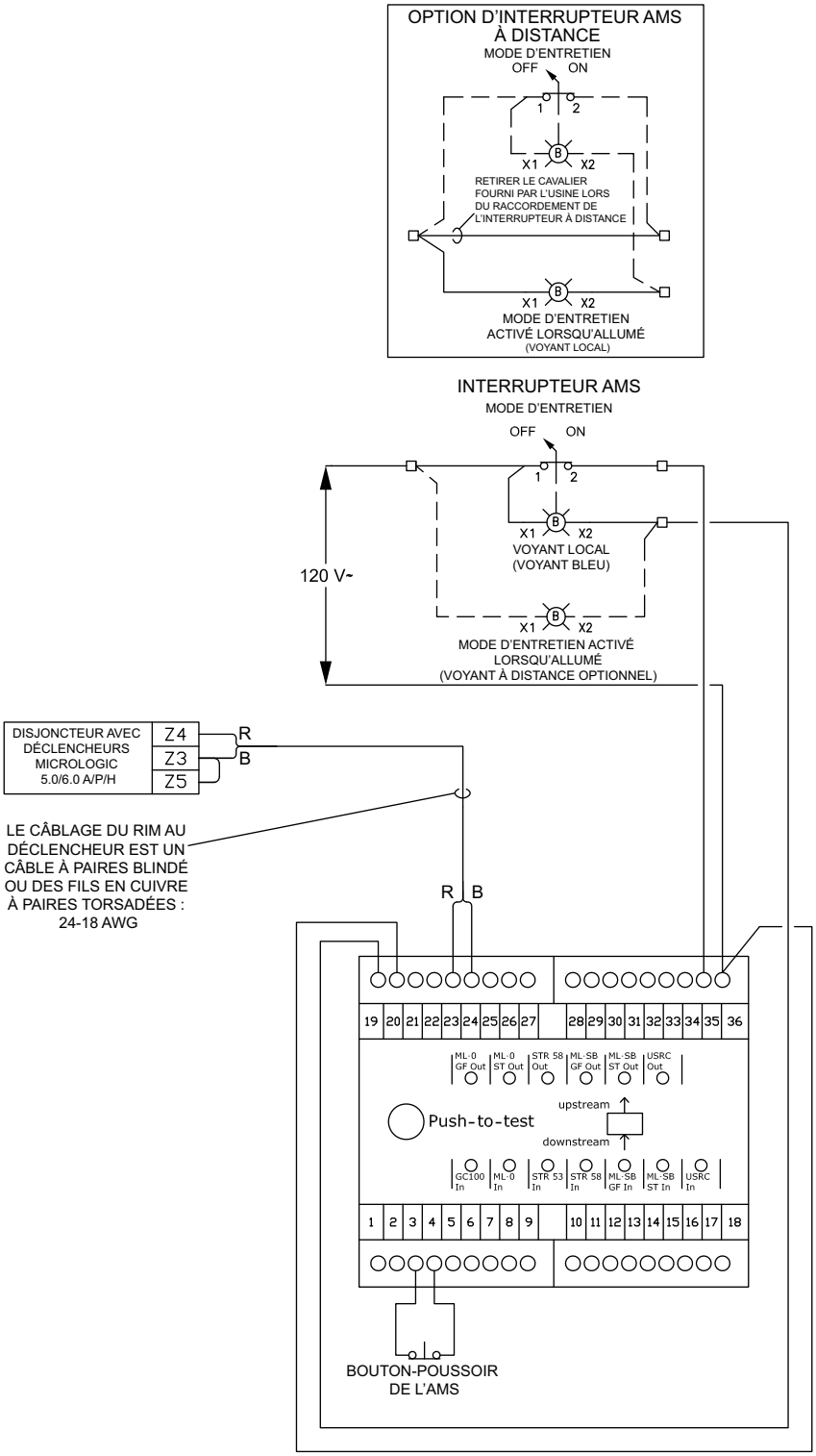
Figure 7 : Schéma de câblage



Schneider Electric Canada
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Toronto, Ontario M4B 1Y2
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www.schneider-electric.ca

Alternate Maintenance Setting (AMS) Switch
Conmutador de ajuste de mantenimiento alternativo (AMS)
Interrupteur de réglage d'entretien alternatif (AMS)

Schneider Electric
8821 Garners Ferry Road
Hopkins, SC 29061 USA
1-888-SquareD (1-888-778-2733)
www.schneider-electric.us

80298-171-01 **09/2009**

Importado en México por:
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80298-171-01 **09/2009**

Alternate Maintenance Setting (AMS) Switch

Power-Zone® 4 Low Voltage Metal-Enclosed Drawout Switchgear

During day-to-day operation and maintenance of low voltage drawout switchgear, circumstances may exist where work must be done within the Limited Approach Boundary of energized conductors or components. In these cases, de-energizing the equipment may not be feasible due to electrical system design or operational limitations that introduce additional or increased hazards to personnel.

How does one decrease the hazard associated with potential arc flash? The use of an Alternate Maintenance Setting (AMS) Switch may be a desirable option for Low Voltage Drawout Switchgear.

Combined with the Masterpact® low voltage drawout circuit breaker, an AMS Switch option may decrease the time an arcing fault is allowed to exist. Since the thermal incident energy from an electric arc exposure is directly proportional to the time duration of the arc, reduction in the reaction time of the upstream protective device will result in less arc-flash hazard to any nearby personnel. It is desirable to clear the arcing fault as quickly as possible while maintaining overcurrent coordination of the distribution system.

The AMS Switch option provides a lockable switch that can be an integral part of your Lock Out/Tag Out (LOTO) procedure. Once the work has been preformed, the switch can be returned to normal settings that provide the optimal protection and coordination.

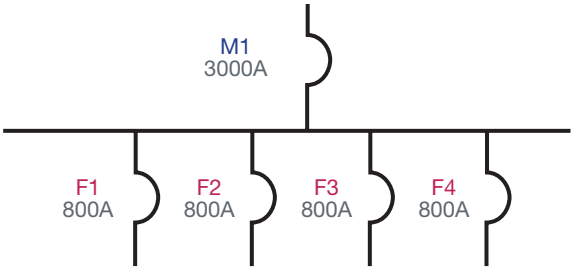
Power-Zone 4 Low Voltage
Metal-Enclosed Drawout Switchgear

SQUARE D®

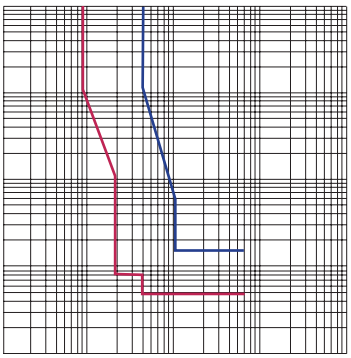
by Schneider Electric

How does the AMS Switch aid in reducing Arc-Flash Incident Energy (AFIE)?

Let us look at a typical low voltage electrical distribution system, such as the one illustrated by the drawing below. A desirable feature of this or any system would be electrical coordination. Electrical coordination is where the protective device immediately upstream of a fault would clear the fault without effect to other upstream protective devices. This is accomplished many times by intentionally inputting time delays at points along the protective device's trip curve.



The use of time current curves provides the insight required to ensure the coordination of the electrical system. The time current curves of both the main and feeder circuit breakers are plotted on the graph to the right; we can see that the main circuit breaker's trip curve is above and to the right of the feeder circuit breaker's trip curve. This enables the overcurrent protection of various portions of the electrical system and enables any fault on the load side of the feeders to be cleared by the appropriate feeder.

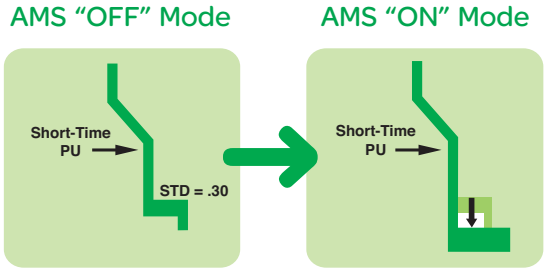


Reducing arc-flash incident energy (AFIE) levels has become an increasingly important consideration when designing electrical power systems. However, selective coordination of overcurrent protective devices is equally important, and both are often misunderstood. The best solution is to provide superior AFIE reduction without sacrificing selectivity.

In order to quantify the arc-flash incident energy reduction, an arc-flash analysis must first be performed. Values must be calculated for the possible maintenance setting to determine if any practical difference to maintenance procedures (such as PPE levels) is even possible.

AMS Switch Features

- Reduces the arc-flash incident energy hazard through the elimination of intentional short time delays when activated
- Maintains existing electrical system coordination when in use



Masterpact® Arc-Flash Protection Circuit Breakers

Square D® brand Masterpact NW and NT low voltage power circuit breakers feature breakthrough technology that provides superior arc-flash protection especially at higher fault currents when a Zone Selective Interlocking (ZSI) scheme is used. When properly applied, they reduce AFIE without changing settings or temporarily compromising the system selective coordination.

Masterpact NW Drawout Power Circuit Breaker

Masterpact Circuit Breaker Features

- Provides arc-flash protection comparable to fast-acting current limiting fuses at high currents and better protection than fuses at lower currents.
- Simplifies calculations for the flash-protection boundary due to testing by Schneider Electric and published AFIE levels.
- Available in Square D brand equipment: PZ4 low voltage drawout ANSI switchgear, QED6 and QED2 UL-rated switchboards, and Model 6 low voltage motor control centers.

What is arc-flash?

According to NFPA 70E-2009, arc-flash is a “dangerous condition associated with the release of energy caused by an electrical arc.” It is measured in terms of arc-flash incident energy (AFIE), which is used to determine the appropriate level of Personal Protection Equipment (PPE), and in terms of an arc-flash protection boundary.

> To learn more

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February 2010

EATON | Cutler-Hammer

Digitrip 520MC with Maintenance Mode

Effective May 2006
I.S 70C1454
Supplement to I.L. 70C1037

FIGURE 1. Digitrip 520MC with ARMs in Magnum Circuit Breaker

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WARNING

ONLY CERTIFIED AND COMPETENT PERSONNEL SHOULD ATTEMPT TO INSTALL OR MAINTAIN POTENTIALLY HAZARDOUS EQUIPMENT.

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING. ALWAYS FOLLOW SAFETY PROCEDURES.

EATON IS NOT LIABLE FOR THE MISAPPLICATION OR MISINSTALLATION OF ITS PRODUCTS.

CAUTION

OBSERVE ALL RECOMMENDATIONS, NOTES, CAUTIONS, AND WARNINGS RELATING TO THE SAFETY OF PERSONNEL AND EQUIPMENT. OBSERVE AND COMPLY WITH ALL GENERAL AND LOCAL HEALTH AND SAFETY LAWS, CODES, AND PROCEDURES.

CAUTION

A FLASH HAZARD ANALYSIS SHOULD BE DONE TO DETERMINE PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

1.0 General

Per the above WARNING, it is highly recommended that maintenance be conducted on electrical equipment including circuit breakers with the system de-energized.

For situations that arise where this is not possible, the Maintenance Mode function of the Digitrip 520MC family (cat 5ARMLSI, 5ARMLSIG, 5ARMLSIA) can reduce Arc Flash incident energy that is generated on a fault condition. This is accomplished by a analog trip circuit which, when armed, provides a fast acting response to the fault. The reduced arc condition will occur only in devices downstream of the trip unit in Maintenance Mode. This is separate from the normal system protection setting of Instantaneous. The Maintenance Mode is located in the upper, white portion of the unit.

2.0 Maintenance Mode Settings

The Maintenance Mode Settings (labeled R5, R4, R3, R2, R1) provide the Arc Flash Reduction setting. R5 is the Maximum reduction setting which correlates to the lowest pickup value.

Nominal Trip current of Maintenance Mode Settings

Setting R5	2.5x	Rating Plug Amperes
Setting R4	4.0x	Rating Plug Amperes
Setting R3	6.0x	Rating Plug Amperes
Setting R2	8.0x	Rating Plug Amperes
Setting R1	10x	Rating Plug Amperes

3.0 Arming Maintenance Mode

There are three ways to arm the Maintenance Mode Arc Flash Reduction setting. One method is locally via the two position switch in the Maintenance Mode section of the trip unit. Turning the switch to the ON position will arm the setting selected. A blue LED confirms that the function is on.

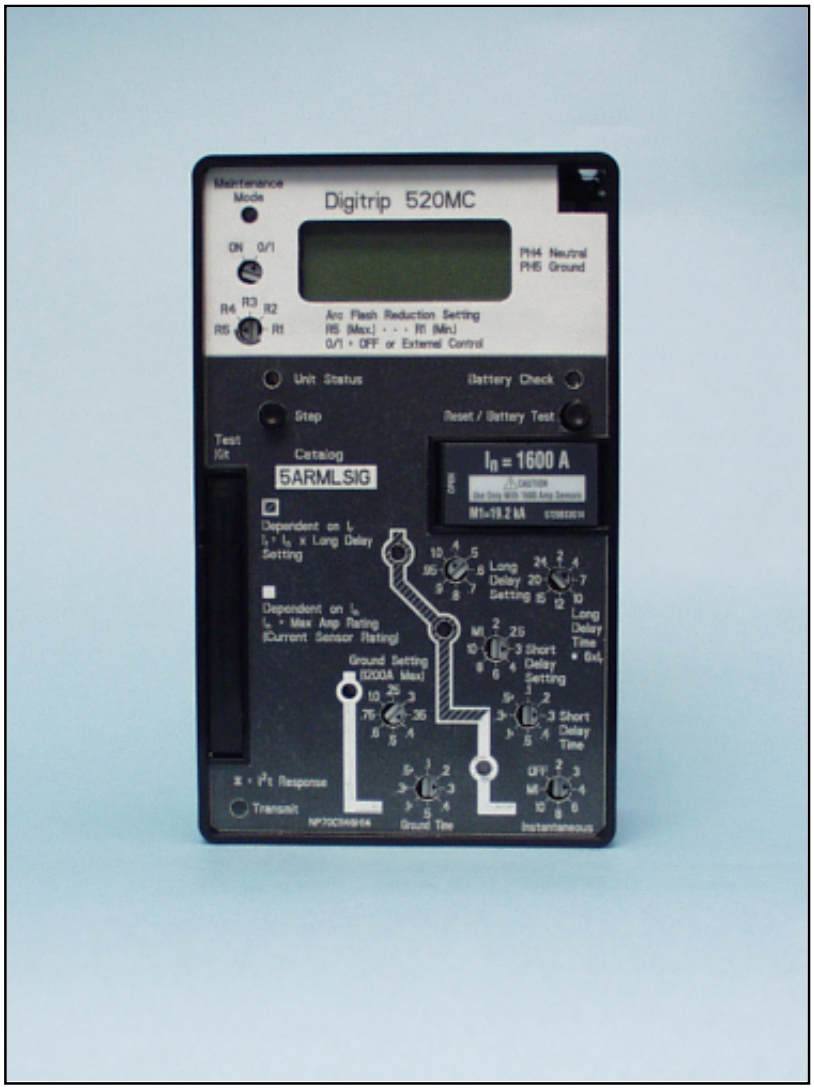


FIGURE 2. Digitrip 520MC with ARMs

For the other two methods of arming the Maintenance Mode function, this switch must be in the position labeled 0/1.With this setting, a remote switch wired through the breaker secondary contacts can remotely arm the Maintenace Mode setting. A high quality, gold plated or palladium contact is required in this application.The blue LED will verify that the function is armed. *(See wiring diagram on page five.)*

A third method to arm the maintenance setting is via a communication device. A Palm Pilot along with an IR Mint device can be employed to arm the setting. By initiating the ENABLE setting, the Maintenance Mode selection in the control screen of the Palm, Maintenance Mode is set. There is a confirmation screen that verifies the arming. A BIM (Breaker Interface Module) is another communcation method to arm the setting. When Maintenance Setting is enabled via device communications, this setting must be disabled by device communications.

4.0 Remote Indicator

The Magnum circuit breaker will be wired with secondary contacts A9 and A12. Circuit breakers built after September 2005 have a normally open contact available for customer use. This contact can be used to indicate remotely that the Maintenance setting is armed. Refer to diagram on page three for a wiring of this remote (blue light) indicator.

5.0 Choosing the Reduction Setting

The Arc Flash Maintenance Switch is an eight position rotary switch that has five unique settings. Setting R5 is repeated four times. From the factory, the Magnum circuit breaker is shipped with the Digitrip unit set to the R5 setting and with its arming switch set to the 0/1 position. The 0/1 position means that it is locally OFF, but can be remotely turned ON. The blue LED, if illuminated, provides indication that the Maintenance Mode setting is armed per one of the three methods described in section 3.0.
In general, the selection of one of the Reduction Settings (R5 through R1) should be determined and selected by a person who is experienced in power system analysis.

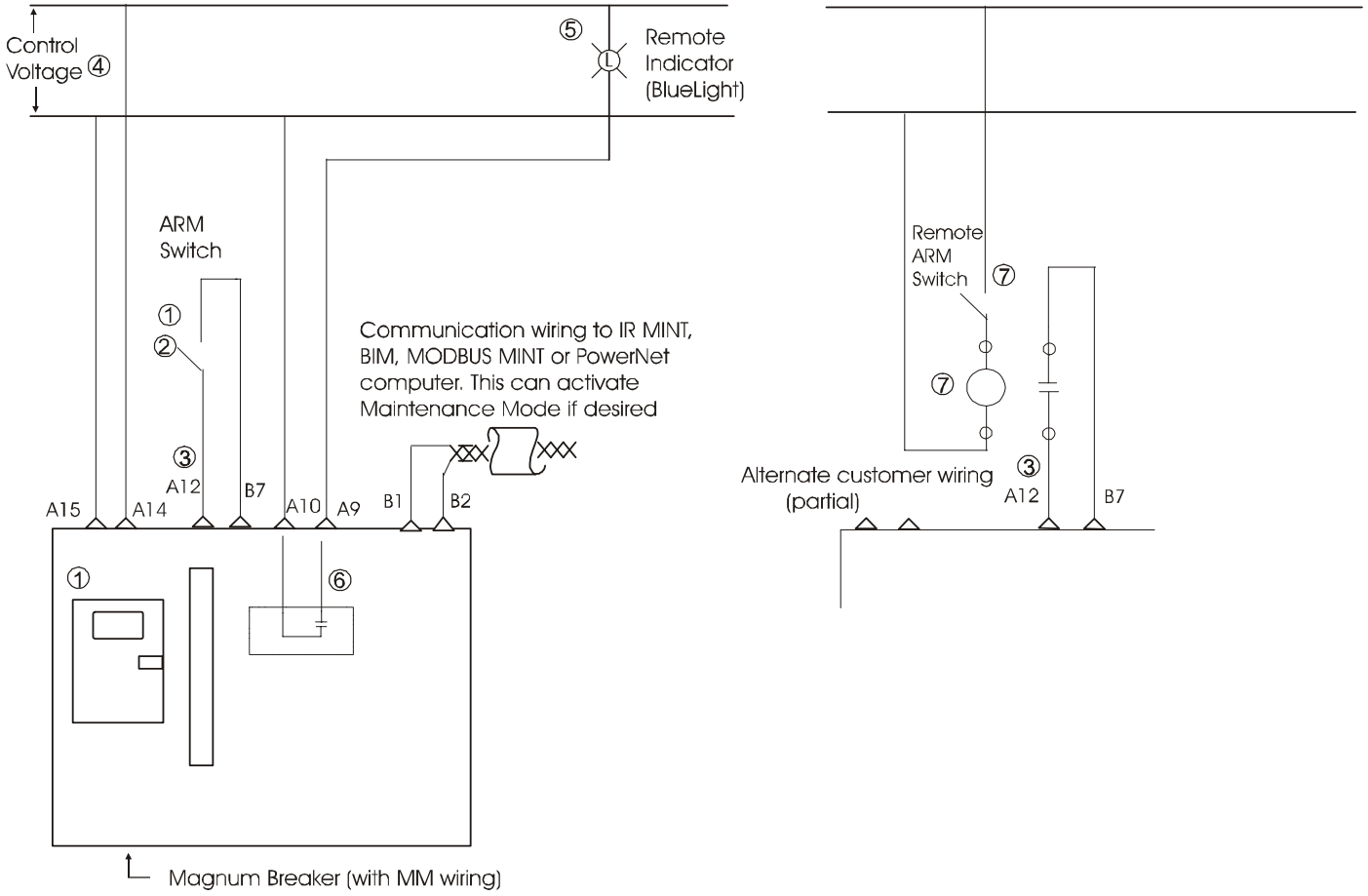
This setting choice normally does not change unless there are future system modifications that could increase or decrease fault levels at the circuit breaker location.

6.0 Tripping and Testing

The Maintenance Mode function will provide fast tripping even when the regular Instantaneous is set to OFF. The Instantaneous LED position is also used to indicate a trip initiated by the Maintenance Mode setting. The LCD display, if powered, will indicate this with four dashes.

The Maintenance setting, external wiring (if any) and tripping functionality should be periodically verified by primary or secondary injection current testing.

Maintenance Mode Wiring Digitrip 520MC



Notes:

① The Digitrip 520MC (Cat 5ARMxxx) can locally be placed in Maintenance Mode via 2 position switch located on the Trip Unit. The function can also be armed via a remote switch as shown. In addition the function can be activated via communications. A blue LED on the Digitrip verifies the Digitrip is in Maintenance Mode.

② The recommended selector switch for this low voltage application is Cutler-Hammer part number 10250T1333-2E which includes a contact block rated for Logic Level and Corrosive Use.

③ The maximum length of this wiring to remote Arm switch(or alternate relay contact) is 3 meters (9.78 feet) Use # 20 AWG wire or larger.

④ Control voltage is 120 VAC or 230VAC or 24 - 48 VDC or 125VDC. Check Magnum circuit breaker front cover for Trip Unit power requirements.

⑤ A remote Stack Light, Annunciator Panel or other remote indication device can be connected to verify that Digitrip is in Maintenance Mode.

⑥ Relay in (GF Alarm/PS Module) makes when in Maintenance Mode. Contact is rated 1A @ 120VAC or 0.5A @ 230VAC or 1A @ 24 - 48VDC and 0.35A @ 125VDC.

⑦ The Digitrip 520MC can also be placed remotely in its Maintenance Mode via a General Purpose Relay -ice cube type with logic level contacts-activated by remote control switch. A recommended type is IDEC Relay RY22.Choose voltage as desired.

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Printed in USA
Publication No. I.S.70C1454H02
May 2006

SECTION 26 09 13

POWER MONITORING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the DRAWINGS, specified and required to furnish and install a complete Power Monitoring System for associated equipment.
   2. Power monitoring shall be provided for all Service Entry locations, Main Breaker locations, motor loads greater than 50 Horse Power, and other loads as specified by ENGINEER.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown and specified.
   1. Meter surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6KV).
   2. The meter shall meet the accuracy requirements of IEC687 (class 0.2%) and ANSI C12.20 (Class 0.2%).
   3. The devices shall be UL listed.
   4. The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs.

B. For retrofitting existing equipment, new components shall meet the equipment UL requirements.

1.3 SUBMITTALS

A. If the power monitoring equipment being supplied is part of new MCC, Switchgear, etc. then provide submittal information as part of the new equipment submittal.

B. Shop Drawings:
   1. Submit for approval the following:
      a. Manufacturer's technical information for equipment proposed for use.
      b. Outline and summary sheets with schedules of equipment in each unit.
      c. Unit control schematic and elementary wiring diagrams showing numbered terminal points, interconnections to other units, wire colors and wire labels.
      d. Front elevation and equipment installation details.

C. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including copies of all Record wiring diagrams, test reports, maintenance data and schedules, description of operation, and spare parts information.

2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Meters:

1. All meters shall have the following ratings, features, and functions; unless a specific meter type is designated.
   a. Meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The Meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
   b. The meter shall be user programmable for voltage range to any PT ratio.
   c. The meter shall have a burden of up to .36VA per phase, Max at 600V, 0.014VA at 120 Volts.
   d. The meter shall accept a direct voltage input range of up to 576 Volts Line to Neutral, and a range of up to 721 Volts Line to Line.
   e. Meter shall accept a current input of up to 10 amps continuous. Start up current for a 5 Amp input shall be no greater than .005 Amps.
2. The meter shall have the following additional ratings and features:
   a. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
   b. Meter shall be programmable for current to any CT ratio. The use of DIP switches for selecting fixed ratios shall not be acceptable
   c. Meter shall have a maximum burden of 0.005VA per phase, at the maximum at 11 Amperes continuous input.
   d. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.
   e. The meter shall accept current inputs of class 10: (0 to 11A), 5 Amp Nominal, and class 2 (0 to 2A), 1A Nominal Secondary.
   f. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions.
   g. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.
   h. The meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
   i. The meter shall utilize 24 bit Analog to Digital conversion.
   j. Meters shall provide Volts, Amps, kW, kVAR, PF, kVA, Frequency, kWh, kVAh, kVARh and 1 KYZ pulse output.
   k. Meters shall provide total % THD (Total Harmonic Distortion) Monitoring to the 40^{th} order for Voltage and current per phase, and shall provide Volts, Amps, kW, kVAR, PF, kVA, Frequency., kWh, kVAh, kVARh and 1 KYZ pulse output and limit exceeded alarms.
3. The meter shall include an LED display.

a. The meter must display a % of FULL SCALE on the front panel to provide an analog feel. The % FULL SCALE shall have not less than 10 segments.

4. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
5. The meter shall include 1 independent communications port on the back, with advanced features.
   a. The port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
   b. Baud rates shall be from 9600 baud to 57,600 baud.
6. The meter shall provide user configured fixed window or sliding window demand. This shall allow the user to set up the particular utility demand profile.
   a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
   b. All other parameters shall offer max and min capability over the user selectable averaging period.
   c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
   d. The meter shall be capable of operating on a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal Power AC/DC Supply shall be available.
   e. Meter AC/DC power supply shall accept burden of 10VA max.
7. Meter shall provide update rate of 100msec for Watts, Var and VA. All other parameters shall be 1 second.
8. The meter shall provide Limits Alarms and Control Capability as follows:
   a. Limit ranges can be set for any measured parameter.
   b. Up to 16 limit ranges per parameter can be set.
   c. Limit ranges shall be based on % of Full Scale settings.
   d. Manual relay control shall be available through software
   e. Relay set delays and reset delays shall be available
9. The meter shall have an option for data-logging capability with 128 Kilobyte memory. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter shall have two logs:
   a. The meter shall have one historical log for trending profiles. The log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to adjust logging intervals between the total logged parameters in order to increase or decrease the time allotted to the log.
   b. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, and Programmable Settings Change.

10. The meter shall have I/O expandability through two Option card slots on the back.
    a. The cards shall be capable of being installed in the field, without removing the meter from installation.
    b. The meter shall auto-detect the presence of any I/O Option cards.
11. Power meter shall be able to be stored in (-20 to +70) degrees C.
    a. Operating temperature shall be (-20 to +70) degrees C.
12. A NEMA 12 faceplate rating shall be available for the meter.
13. Manufacture and Model
    a. Eaton IQ26065100
    b. Or Pre-Approved equal.

B. Current Transformers:
1. Current rating – the primary current shall be based on the monitored equipment, the secondary current shall be 5.0 Amps.
2. Burden
    a. For Service entry the meter burden of up to 0.005VA per phase, Max at 11 Amps should be used.
    b. For non-service entry applications the burden as required for the connected loads should be used.
3.
4. Accuracy requirements (to be specified on DRAWINGS)
    a. Service entry power monitoring applications require higher accuracy than general load monitoring and protection applications.
        1) Service entry applications require revenue grade Current Transformers (0.3% accurate or better).
        2) Service entry power monitoring revenue grade Current Transformers are to be separate from the protective circuits Current Transformers.
    b. Unless specified otherwise, all other applications require only standard protection grade Current Transformers (typically 2.0-3.0% accurate).
5. Mountable Split Core Current Transformers are to be provided, as long as the accuracy requirements for the specific application are maintained. ENGINEER may approve exceptions to this requirement in whole or in part.
6. Current Ratio as specified on DRAWINGS or as approved by ENGINEER.

C. Potential Transformers:
1. Provide Potential Transformers for medium voltage applications and above and are specified based on the specific application.
2. Burden
    a. The meter burden of up to .36VA per phase, Max at 600V, 0.014VA at 120 Volts should be used.
3. Nominal secondary voltage to be 120 VAC.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. As specified in the manufacturers installation guide and as shown on the DRAWINGS.

3.2 INSTALLATION

A. When retrofitting existing equipment install new components per manufacturer's recommendations.

B. For new equipment installation and qualification will be performed at equipment fabrication site.

3.3 TESTING REQUIREMENTS

A. Once equipment is energized the Contractor in coordination with ENGINEER and OWNER shall verify all power monitoring meters communicate with the site specific computer system and the data received is correct for the component monitored.

+ + END OF SECTION + +

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SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install lighting fixtures and controls.

B. Coordination:
   1. Coordinate location of fixtures with piping, ductwork, openings and other systems and equipment and locate clear of interferences.
   2. Coordinate fixtures to be mounted in hung ceilings with the ceiling suspension system proposed for use.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Illuminating Engineer's Society.
   2. National Electrical Code (NEC) current adoption.
   3. City of Phoenix – Amendments to the National Electrical Code.
   4. UL Standard No. 57, Electric Lighting Fixtures.
   5. UL Standard No. 844, Electric Lighting Fixtures for Use in Hazardous Locations.
   6. UL Standard No. 917, Clock-Operated Switches.
   7. UL Standard No. 1570, Fluorescent Lighting Fixtures.
   8. UL Standard #1571, Incandescent Lighting Fixtures.
   9. UL Standard #1572, High Intensity Discharge Lighting Fixtures.
   10. City of Phoenix Lighting Ordinance No. G2699 for Exterior Lighting.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer’s catalog cuts and technical information for lighting fixtures proposed for use.
   2. Fixture construction details.
   3. ETL photometric and isocandle curves for each fixture proposed.
   4. Verification that recessed fixtures which are to be mounted in hung ceilings are compatible with the ceiling suspension system proposed for use.
   5. Manufacturer’s technical information for lighting controls proposed for use.
   6. Wiring diagrams.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Type: Lighting fixtures are noted in the Fixture Schedule on the Drawings. Fixtures to be complete with supports, ballasts, lamps and incidentals, as required.

B. Lamps:
   1. Fluorescent: Cool white, energy efficient type.
   2. High Pressure Sodium: Color corrected.
   3. Light Emitting Diode (LED)
   4. Spare: Ten percent spare lamps of each type and wattage.

C. Ballasts:
   1. Fluorescent: High power factor, energy efficient type, equipped with thermal protectors (Type "P" ballast), compatible with the lamps installed.
   2. High Intensity Discharge: High power factor, constant wattage, stabilized autotransformer with line starting current the same or less than operating current.
   3. Ballasts to have "C" sound rating (min.) and be ETL/CBM certified.
   4. Spare: Ten percent spare ballasts of each type.

D. Fixtures located in an area which is identified as a hazardous location shall be approved as a complete assembly for the hazardous location classification as shown on the Drawings, shall be clearly marked to indicate maximum wattage of lamps for which they are approved, and shall be protected against physical damage by suitable guards.

E. Hardware: All necessary hangers, supports, conduit adaptors, reducers, hooks, brackets and other hardware required for safe fixture mounting shall be furnished. Hardware shall have a protective, non-corrosive finish.

F. Time Switch:
   1. Type: Astronomic dial time switch with day-omitting device.
   2. Timing Motor: Heavy duty, synchronous, self-starting, high torque, 120 volt or 277, 60 cycles, as shown on the Drawings.
   3. Capacity: 40 Amps per pole at 277 volts.
   4. Dial: 24 hour rotation, with gear to provide one revolution per year which automatically raises the ON and OFF settings each day according to seasonal changes of sunset and sunrise for the City of Phoenix, Arizona area.
   5. Reserve Power: Spring driven reserve sufficient to operate time switch contacts for a minimum of 30 hours after power failure. On restoration of power, time switch shall transfer to synchronous motor drive and automatically rewind reserve.
   6. Product and Manufacturer: Provide one of the following:
      a. Z Series by Tork Time Controls, Incorporated.
      b. Or equal.

G. Combination Lighting Contactors:
   1. Rated 600 volts, 30 amps, electrically held number of poles as shown on the Drawings, housed in NEMA 12 enclosure.

2. Additional devices such as selector switches, circuit breakers, control power transformers, fuses, time clocks etc., as shown on the Drawings.
3. Product and Manufacturer: Provide one of the following:
   a. General Electric.
   b. Allen-Bradley.
   c. Or equal.

H. Photocell:
1. Cadmium sulphide hermetically sealed cell, fully temperature compensated, with time delay of at least 15 seconds to prevent false switching.
2. Built-in fail safe light level selector, adjustable within limits of 2 to 50 foot candles and factory set at 25 foot candles.
3. Product and Manufacturer: Provide one of the following:
   a. 2100 Series by Tork Time Controls, Incorporated.
   b. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Fixture mounting heights and locations as shown on the Drawings are approximate and are subject to revision in the field, where necessary to clear conflicts and obstructions.

B. Suspended Fixtures: Pendant mount using 1/2-inch conduit stems. Ground to outlet box. Attach mounting to building structure with expansion anchors. Fixtures shall not be dependent on the outlet box cover screws for support.

C. Surface Mounted Fixtures: Attach to appropriate outlet box.

D. Boxes and Fixtures:
1. For units mounted against masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers or Unistrut.
3. No boxes shall be installed with open conduit holes.
4. Cable each circuit and identify with tag.

E. Mounting Heights: Mounting heights or elevations are to bottom of the fixture or to centerline of device.

F. Relamp all fluorescent fixtures with new lamps at end of construction period, prior to Final Completion of the new facilities by OWNER.

G. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

H. Mount photocell as shown on the Drawings and adjust footcandle setting for proper dusk and dawn photocontrol. Provide wiring in conduit from the photocell to controls.

I. Securely fasten equipment to walls or other surfaces on which they are mounted.

J. Install fixtures in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 26 18 49

COMBINATION MAGNETIC MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install combination magnetic motor starters.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. NEMA Standard ICS2-110, General Standards for Manual and Magnetic Controllers.
   2. NEMA Standard ICS2-321 AC General Purpose Class A Controller for Squirrel Cage Induction Motors, 600 volts and less.
   3. NEMA 250, Enclosures for Electrical Equipment (1,000 volts maximum).
   4. UL Electrical Construction Materials Directory (NLDX).
   5. National Electrical Code (NEC) current adoption.
   6. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer’s technical information for combination magnetic motor starters proposed for use.
   2. Listing of the combination magnetic motor starters to be furnished with their location, NEMA size and enclosure type and equipment to be controlled identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Type: Combination type with magnetic only motor circuit protector. Magnetic coil operated, horsepower rated with thermal overload protection.
   2. Enclosures: NEMA 1 for dry, indoor locations and NEMA 4X non-metallic or Type 316 stainless steel for outdoor and damp, wet or corrosive indoor locations.
   3. Functional Type: Full voltage, single speed, non-reversing, unless otherwise shown on the Drawings.
   4. Control power transformer fused and grounded on low voltage (120 VAC) side for each starter.

5. Auxiliary contacts for motor space heaters, remote status signals and interlocks as shown on the Drawings.
6. Overload Relays:
   a. Overload relays shall be three bimetallic, adjustable types, with separate heater elements sized for the full load amperes and service factor of the actual motors furnished. Provide manual reset from outside the enclosure by means of an insulated button with normally open auxiliary dry contacts for remote alarm and local indication purposes. Overload relay shall be ambient-compensated where the motor is held at a constant ambient temperature that may be different relative to varying temperatures at the location of the Starter/Overload. Where the Starter/Overload is located outdoors and the motor is indoors or submersed in liquid such as submersible pumps.
7. Start and stop control stations, selector switches, pilot lights and other devices as shown on the Drawings.
8. Provide factory installed engraved manufacturer's nameplate identifying the equipment controlled.

B. Product and Manufacturer: Provide one of the following:
   1. Square D Company.
   2. Allen Bradley Company.
   3. General Electric Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount controller so that sufficient access and working space is provided for safe operation and maintenance.

B. Securely fasten enclosure to wall or other mounting surfaces. Where local wall is not available, provide stainless steel supports to rigidly support equipment reasonably close to motor.

C. Install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 26 21 00

SERVICE ENTRANCE SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals, including concrete pad, as shown on the Drawings, specified and required to furnish and install free-standing metal enclosed, low voltage draw out Service Entrance Section switchgear lineups at water and wastewater treatment plants, complete and operational as shown on the Drawings and as specified herein. Each metal enclosed switchgear assembly shall consist of completely metal enclosed vertical sections and include the quantity of low voltage, draw out circuit breakers as required by the Contract Documents.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the service entrance sections.
   2. Refer to and comply with the requirements of work in this Section along with the requirements of the Sections listed below which includes but is not limited to work that is directly related to this section.
      a. Section 01 33 23.10, Shop Drawing Procedures.
      b. Section 01 78 23, Operations and Maintenance Data.
      c. Section 01 79 00, Instruction of Operations and Maintenance Personnel.
      d. Section 09 90 00, Painting.
      e. Section 26 43 00, Surge Protection Devices.
      f. Section 26 09 13, Power Monitoring System.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown and specified.
   1. IEEE C37.13, Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   2. IEEE C37.20.1, Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
   3. Electric Utility Service Equipment Requirements Committee (EUSERC)
   4. UL 1558, UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
   5. National Fire Protection Association 79, Electrical Standards for Industrial Machinery.

6. International Building Code (IBC) as supplemented by the City of Phoenix, Building Construction Code.
7. ANSI/NETA ATS-2017, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

C. For the equipment specified herein, the manufacturer shall be ISO 9000 or 9001 certified

D. The manufacturer of the assembly shall be the manufacturer of the circuit protective devices within the assembly.

E. The switchgear shall be suitable for and certified to meet all applicable seismic requirements of the Uniform Building Code as supplemented by the City of Phoenix Building Construction Code for Zone 2 applications. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
2. CONTRACTOR shall submit an electronic copy per Specification Section 01 33 23.10, Shop Drawing Procedures. Text shall be in electronic ASCII format. Drawings and figures shall be in Version 2012 or newer AutoCAD ".dwg," or pdf ".pdf" format.
3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The CONTRACTOR shall furnish equipment and/or services as specified if an exception and/or deviation is rejected. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. The CONTRACTOR shall submit the preventive maintenance information package as part of the shop drawing submittal package to the ENGINEER for review and approval. **SHOP DRAWING SUBMITTAL PACKAGE WILL NOT BE APPROVED WITHOUT ACCEPTANCE OF PREVENTIVE MAINTENANCE INFORMATION AS DESCRIBED IN SPECIFICATION SECTION 01 78 23.**
5. Manufacturer's technical information for equipment proposed for use.

Submittals shall include the following:

a. Dimensional information.
b. Three-line diagrams.
c. Technical specifications.
d. Catalog cuts.
e. Construction details of enclosure.
f. Schematic control diagrams for breaker control and all other controls.
g. Component List.
h. Conduit entry/exit locations.
i. Assembly ratings including:
    1) Short Circuit Rating.
    2) Voltage.
    3) Continuous Current.
j. Major component ratings including:
    1) Voltage.
    2) Continuous Current.
    3) Interrupting Ratings.
k. Cable terminal sizes.
l. Certified production test reports.
m. Wiring Diagrams.
n. Installation information, including seismic certification and equipment anchorage details
o. Provide submittal to Utility meter shop for approval. Switchboard shall not be released for production prior to Utility approval.

B. Utility Review: Submit for Utility review and reference project and customer name, Utility job number, job address, contractor's name and phone number on the submittal drawings. Service entrance section and switchgear must be approved for connection by the serving utility company prior to Engineer's review. Include Utility approval letter in the SES/switchgear submittal to Engineer.

C. Certification of Ratings: Submit for approval copies of certifications as follows:
1. The integrated switchgear assembly shall have a BIL rating established by test on switchgear of the type to be furnished under this Specification. Certified test abstracts establishing such ratings shall be furnished.

D. Where applicable, the following additional information shall be submitted to the ENGINEER:
1. Busway connection.
2. Connection details between close-coupled assemblies.
3. Composite floor plan of close-coupled assemblies.
4. Key interlock scheme drawing and sequence of operations.

E. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals, including, test reports, certificate of ratings, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at the time of shipment.

C. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage that exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

D. Store materials to permit easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

E. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition.

F. Refer to and comply with the requirements of Section 01 65 00, Product Delivery Requirements and Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 RATINGS

A. The switchgear shall be rated for 600 volts service with a 3-phase, 4-wire bus rating as shown on the Drawings. Bus shall be braced for a symmetrical short circuit current of at least 100,000 amps.

B. Voltage, Phase and Wire sizing shall be per Drawings.

2.2 MATERIALS

A. General: The metal-enclosed switchgear assembly shall consist of multiple self-supporting bays. The sections shall contain draw out power air circuit breakers.

B. Construction:
   1. The switchgear shall consist of a stationary structure constructed from individual vertical sections as shown on the Drawings. The vertical sections shall be bolted together to form a rigid metal-clad switchgear assembly. Metal sheets shall provide grounded metal barriers between adjacent sections. Each vertical section shall contain one or more individual breaker or instrument compartments and a rear compartment for the bare busses and outgoing cable connections. Barriers shall be provided to isolate the cable compartment from the horizontal and vertical bus compartments. Where low voltage busway entry

is required into top of main breaker sections, provide necessary cutout and switchgear bus risers and auxiliary hardware. Connection to low voltage busway shall be tin-plated, copper bus. Cable connection is not acceptable.

2. Each breaker compartment shall be equipped with primary and secondary contacts, draw out extension rails, stationary levering mechanism parts and required instrument transformers. A formed steel door equipped with an emergency trip button and supported on concealed hinges with removable pins shall be provided for each circuit breaker compartment.
3. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. All busses and connections shall consist of tin-plated copper bar mounted on heavy duty supports. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers. A tin-plated copper ground bus (minimum ¼ by 2-inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear.
4. Each circuit shall include the necessary three-phase bus and connections between the bus and one set circuit breaker studs. Provide NEMA two-hole cable lugs attached to tin-plated copper extensions for the outgoing cables on the other set of circuit breaker studs.
5. Terminal blocks with integral type barriers shall be provided for secondary circuits. The terminal blocks shall be front accessible through a removable tray above each circuit breaker. All control wiring shall be securely fastened to the switchgear assembly without the use of adhesive wire anchors. A dedicated wiring path shall be provided for customer's control wiring.
6. The stationary part of the primary disconnecting devices for each circuit breaker shall consist of a set of contacts extending through a glass polyester insulating base. Busses and outgoing cable terminal shall be directly connected to them. The corresponding moving contacts shall consist of a set of contact fingers suitably spaced on the circuit breaker studs. In the "CONNECTED" position, these contacts shall form a current-carrying bridge. High uniform pressure on each finger shall be maintained by springs. Contact engagement shall be maintained only in the "CONNECTED" position.
7. The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging contacts located at the rear of the compartment. The secondary disconnecting devices shall be silver-plated to ensure permanence of contact. Contact engagement shall be maintained in the "CONNECTED" and "TEST" positions.
8. Each removable breaker element shall consist of an air circuit breaker equipped with the necessary disconnecting contacts, wheels and interlocks for draw out application. The removable element shall have four-position features and shall permit closing the compartment door with the breaker in the "CONNECTED", "TEST", "DISCONNECTED" and "REMOVE" positions. Door shall be closed and stationary when breaker is racked between "CONNECTED", "TEST" and "DISCONNECTED" positions for added personnel safety.
9. All circuit breakers shall be draw out type, power air circuit breakers, manually operated and have a minimum of 100,000 amps symmetrical interrupting capacity at 480 volts. Breaker frame and trip ratings shall be as shown on the Drawings. All breakers shall be UL listed for application in their intended enclosures at 100 percent of continuous ampere rating. The circuit breakers shall include, where necessary, current-limiting fuses, integrally mounted,

coordinated with the breaker trip device to avoid unnecessary blowing of the fuses. Breakers equipped with current-limiting fuses shall have an anti-single phase device that will trip the breaker in the event of a blown fuse, indicate on the front of the breaker which limiter is blown, and prevent the breaker from being reclosed on a single-phase condition due to missing or blown limiters. Breakers shall have stored energy operating mechanisms. Only one stroke of the operating handle shall be required to charge the stored energy spring when operating the breaker. The release of the energy to close the breaker shall be by means of a mechanical pushbutton to ensure positive control of the closing operation. Both main breakers and the tie breaker shall have key interlocking to prevent no more than two breakers from being closed simultaneously at any time.

a. Each breaker shall be equipped with a microprocessor-based tripping device. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. The trip unit shall be General Electric MicroVersaTrip Plus, Square D Micrologic 6.0 LISG, Eaton Digitrip 1150+ LSIG, ABB SACE PR123/P, or Engineer Approved equal.
b. Provide arc flash reduction module on main breaker 1000 amperes and larger, with control switch and blue light both external to the breaker trip unit indicating in maintenance mode.

10. All control wire shall be No. 14 AWG minimum, Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals shall be provided integral to a device. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring. The color coding of the wires shall be in accordance with NFPA 79.
11. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device.
12. Each compartment labeled as "SPACE" on the Drawings, shall be equipped with provisions for a future, manually operated breaker of frame rating as shown on the Drawings. All breaker locations designated as "FUTURE SPACE" on the Drawings, shall be furnished with all necessary provisions for a future, manually operated circuit breaker.
13. The low-voltage distribution switchboards shall be Service Entrance rated and UL labeled.

C. Miscellaneous devices:
1. Control power transformers with primary and secondary protection shall be provided as shown on the Drawings, and as required for serving space heaters.
2. Each section of the switchgear shall be provided with a thermostatically controlled space heater. Power for the space heaters shall be obtained from a control power transformer within the switchgear, Supply voltage shall be

120VAC.

3. Arc Flash Reduction Module:
   a. For systems that have an Arc Flash Reduction Module installed, there shall be a 1.75" x 5.75" phenolic placard installed, red in color with white font, stating to match Figure 2.2.D below.
   b. Product and Manufacturer shall be BRADY, or equal.

THIS EQUIPMENT IS EQUIPPED WITH AN ARC FLASH REDUCTION MODULE:
Before performing energized electrical work on this equipment, the electrical distribution system shall be placed in the MAINTENANCE Mode "ON" position at the Service Entrance Main Circuit Breaker.
Please refer to manufacturer's procedures for switching this system to maintenance Mode "ON" position.

Figure 2.2.C

D. Metering:
   1. Provide utility and metering devices where shown on the Drawings.
   2. Utility metering compartment. Fabricate compartment and section to meet utility company requirements and EUSERC Standards. Match and align with switchgear.
   3. Provide power monitoring as specified in Section 26 09 13, Power Monitoring System.

E. Manufacturer's Nameplates:
   1. Factory installed engraved manufacturer's nameplates, mounted on the face of the assembly, and shall be furnished for all main, tie and feeder breakers. These nameplates shall be laminated plastic with 1/2-inch minimum, Arial font, black characters on a white background or match existing, secured with stainless steel screws. These nameplates shall also contain item designation, equipment served breaker frame size and breaker trip rating.
   2. All control components within the assembly shall be identified in correspondence to appropriate designations on the manufacturer's wiring diagrams.

F. Accessories:
   1. Portable, breaker lifting device for each lineup.
   2. Portable test kit for testing and verification of trip units. Test kit shall operate on 120 VAC power from any outlet.
   3. Any additional devices as required and as shown on the Drawings.
   4. Levering crank for moving the breaker between "TEST" and "CONNECTED" positions.
   5. Test jumper for electrically operating the breaker while out of its compartment.
   6. Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails.
   7. One set of rail extensions and rail clamps.
   8. Transfer truck (turning dolly) for removing and transporting circuit breakers.
   9. Circuit breaker remote control station for opening and closing the circuit breaker with 50 ft. minimum cord and plug.

10. Remove circuit breaker racking mechanism. Cord and Plug should be 50 ft. minimum. Connection of the mechanism shall be made with the circuit breaker compartment door closed.

G. Infrared Window:
   1. Provide infrared windows for viewing of the line and load side terminals of the main breaker(s).
      a. Size: 4 inch
      b. Window to be provided with a coating to seal the optic prior to assembly to protect against degradation.
      c. Window to be provided with hand turn door latch with identification plate.
      d. Mount window with high temperature silicon gaskets.
      e. Product and Manufacturer: Provide the following:
         1) Fluke ClirVu® CV Series

H. Product and Manufacturer: Provide equipment as needed from the following:
   1. PowerZone 4, as manufactured by Square "D" Company.
   2. Magnum DS, as manufactured by Eaton.
   3. MNS-SG, as manufactured by ABB.
   4. Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance. Seal bottom of equipment with RTV silicone.

B. Install equipment on concrete pad, as shown on Drawings. Coordinate pad dimensions to fit equipment furnished.

C. Responsibility for all overcurrent protection settings as determined by Section 26 05 73, Power System Study belongs to CONTRACTOR. The trip settings shown on the Drawings represent the desired long time pickup setting.

D. Install in accordance with Phoenix Electrical Code.

3.2 FACTORY TESTS

A. The manufacturer shall perform standard factory tests on each circuit breaker. The factory tests shall be witnessed by the ENGINEER. Include the cost of the witness testing in the price. The cost shall include all transportation, lodging and meals.

3.3 FIELD INSPECTION AND TESTS

A. Provide the services of an authorized service representative of the equipment manufacturer to make site visits to supervise the field testing to be performed by CONTRACTOR. The service representative shall be an employee of the manufacturer of the low voltage drawout switchgear. The manufacturer's

representative shall provide certification to the OWNER that the equipment has been correctly installed and shall submit the factory and field test results to the OWNER. The manufacturer's representative shall certify, in writing, that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recom-mendations.

B. Perform the following minimum tests and checks before energizing equipment.
   1. Perform insulation resistance tests on each bus section, phase-to-phase and each phase-to-ground for a period of one minute at 2200 volts DC.
   2. After successful completion of insulation resistance test, perform an over-potential test on each bus section, each phase-to-ground for a period of one minute at manufacturer's recommended voltage.
   3. Inspect all mechanical and electrical interlocks for proper operation.
   4. Perform insulation resistance test on all control wiring at 1500 volts DC after disconnecting devices.

C. The manufacturer shall supply, upon request, test results to confirm that the switchgear assembly design has been tested to substantiate conformance with the applicable ANSI and NEMA Standards. The tests shall verify not only the performance of the switch or integrated switch and fuse, but also the suitability of the enclosure venting, rigidity and bus bracing. In addition, the switchgear assembly shall be factory tested in accordance with ANSI Standard C37.20.3 and the Contract Documents.

D. Perform any other tests recommended by the equipment manufacturer.

E. The testing specified in paragraph above shall be performed by a certified lab under the direction of the manufacturer’s representative.

F. Electrical Acceptance Testing shall be done in accordance with the latest NETA ATS Standard.

G. Provide completed forms 26 05 01-H, Low Voltage Switchgear Test Form, in accordance with Section 01 33 10, Reference Forms.

3.4 MANUFACTURER’S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of three (3) visits, minimum sixteen (16) hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the low voltage drawout switchgear conforms to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

3.5 FIELD ADJUSTMENTS

A. Relay settings on the microprocessor protective devices as required to place the equipment in final operating condition shall be performed by CONTRACTOR in the field in accordance with the recommended settings designated in the coordination study in Section 26 05 73, Power System Study. The CONTRACTOR shall be required to determine the protective device settings that are outside of the Power System Study specification scope of work. The Section 26 05 73 Power System Study Specification provides Overcurrent and Ground protections only. All relay settings shall be reviewed and approved by the ENGINEER.

B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with and approved short circuit and protective device coordination study shall be carried out by CONTRACTOR, at no additional cost to the OWNER.

+ + END OF SECTION + +

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SECTION 26 23 10

LOW-VOLTAGE DRAWOUT SWITCHGEAR

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals, including concrete pad, and associated monitoring and control systems as shown on the Drawings, specified and required to furnish and install indoor, free-standing metal enclosed, low voltage switchgear lineups complete and operational as shown on the Drawings and as specified herein. Each metal enclosed switchgear assembly shall consist of completely metal enclosed vertical sections and include the quantity of low voltage, drawout circuit breakers as required by the Contract Documents.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown and specified.
   1. ANSI/NETA ATS-2017, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. IEEE C37.13, Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   3. IEEE C37.20.1, Metal-Enclosed Low-Voltage (1000Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
   4. IEEE C37.20.7, Guide for Testing Switchgear Rated Up to 52kV for Internal Arcing Faults
   5. UL 1066, UL Standard for Safety Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
   6. UL 1558, UL Standard for Safety Metal-Enclosed Low-Voltage Power Circit Breaker Switchgear.
   7. National Fire Protection Association 79, Electrical Standards for Industrial Machinery.

C. For the equipment specified herein, the manufacturer shall be ISO 9000 or 9001 certified.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.

2. CONTRACTOR shall submit an electronic copy per Specification Section 01 33 23.10, Shop Drawing Procedures. Text shall be in electronic ASCII format. Drawings and figures shall be in Version 2012 or newer AutoCAD ".dwg," or pdf ".pdf" format.
3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The CONTRACTOR shall furnish equipment and/or services as specified if an exception and/or deviation is rejected. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. The CONTRACTOR shall submit the preventive maintenance information package as part of the shop drawing submittal package to the ENGINEER for review and approval. SHOP DRAWING SUBMITTAL PACKAGE WILL NOT BE APPROVED WITHOUT ACCEPTANCE OF PREVENTIVE MAINTENANCE INFORMATION AS DESCRIBED IN SPECIFICATION SECTION 01 78 23.
5. Manufacturer's technical information for equipment proposed for use. Submittals shall include the following:
    a. Floor plans showing dimensioned layout, elevations, sections, details, shipping sections, weights of each assembled section, required working clearances, and required area above and around low-voltage switchgear where pipe and ducts are prohibited.
    b. Include tabulation of installed devices with features and ratings. Indicate short-time and short-circuit current rating of switchgear assembly.
    c. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components. Include Time-current curves (TCC), on full-size logarithmic paper.
    d. Support locations, type of support, and weight on each support. Indicate field measurements.
    e. One Line, and Three-line diagrams. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.
    f. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers.
    g. Equipment Data Sheets and technical specifications including:
        1) Frame size of each circuit breaker.
        2) Trip rating for each circuit breaker.
    h. Construction details of enclosure. Detail locations for anchor bolts and leveling channels.

i. Schematic control diagrams for breaker control and all other controls. Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
j. Include mimic-bus Diagram

6. Test Reports: Electrical Acceptance Testing shall be done in accordance with the latest NETA ATS Standard.

B. Certification of Ratings: Submit for approval copies of certifications as follows:
1. The integrated switchgear assembly shall have a BIL rating established by test on switchgear of the type to be furnished under this Specification. Certified test abstracts establishing such ratings shall be furnished.
2. Seismic Qualification Data: Certificates, for switchgear, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals, including, test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at the time of shipment.

C. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage that exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

D. Store materials to permit easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

E. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition.

PART 2 - PRODUCTS

2.1 RATINGS

A. The switchgear shall be rated for 600 volts service with a 3-phase, 3-wire (or 4-wire) bus rating as shown on the Drawings. Bus shall be braced for a symmetrical short circuit current of at least 100,000 amps.

2.2 MATERIALS

A. General: The metal-enclosed switchgear assembly shall consist of multiple self-supporting bays. The sections shall contain drawout power air circuit breakers.

B. Construction:
   1. The switchgear shall consist of a stationary structure constructed from individual vertical sections as shown on the Drawings. The vertical sections shall be bolted together to form a rigid metal-enclosed switchgear assembly. Metal sheets shall provide grounded metal barriers between adjacent sections. Each vertical section shall contain one or more individual breaker or instrument compartments and a rear compartment for the bare busses and outgoing cable connections. Barriers shall be provided to isolate the cable compartment from the horizontal and vertical bus compartments. Where low voltage busway entry, is required into top of main breaker sections, provide necessary cutout and switchgear bus risers and auxiliary hardware. Connection to low voltage busway shall be tin-plated, copper bus. Cable connection is not acceptable.
   2. Each breaker compartment shall be equipped with primary and secondary contacts, drawout extension rails, stationary levering mechanism parts and required instrument transformers. A formed steel door equipped with an emergency trip button and supported on concealed hinges with removable pins shall be provided for each circuit breaker compartment.
   3. All busses and connections shall consist of tin-plated copper bar mounted on heavy duty supports and shall have bolted joints utilizing Belleville type spring washers. Ground bus shall be full length, copper.
   4. Each circuit shall include the necessary three phase bus and connections between the bus and one set circuit breaker studs. Provide NEMA two-hole cable lugs attached to tin-plated copper extensions for the outgoing cables on the other set of circuit breaker studs.
   5. Terminal blocks with integral type barriers shall be provided for secondary circuits. The terminal blocks shall be front accessible through a removable tray above each circuit breaker. All control wiring shall be securely fastened to the switchgear assembly without the use of adhesive wire anchors. A dedicated wiring path shall be provided for customer's control wiring.
   6. The stationary part of the primary disconnecting devices for each circuit breaker shall consist of a set of contacts extending through a glass polyester insulating base. Busses and outgoing cable terminal shall be directly connected to them. The corresponding moving contacts shall consist of a set of contact fingers suitably spaced on the circuit breaker studs. In the "CONNECTED" position,

these contacts shall form a current-carrying bridge. High uniform pressure on each finger shall be maintained by springs. Contact engagement shall be maintained only in the "CONNECTED" position.

7. The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging contacts located at the rear of the compartment. The secondary disconnecting devices shall be silver-plated to ensure permanence of contact. Contact engagement shall be maintained in the "CONNECTED" and "TEST" positions.
8. Each removable breaker element shall consist of an air circuit breaker equipped with the necessary disconnecting contacts, wheels and interlocks for drawout application. The removable element shall have four-position features and shall permit closing the compartment door with the breaker in the "CONNECTED", "TEST", "DISCONNECTED" and "REMOVE" positions. Door shall be closed and stationary when breaker is racked between "CONNECTED", "TEST" and "DISCONNECTED" positions for added personnel safety.
9. All circuit breakers shall be drawout type, power air circuit breakers, manually operated and have a minimum of 100,000 amps symmetrical interrupting capacity at 480 volts. Breaker frame and trip ratings shall be as shown on the Drawings. All breakers shall be UL listed for application in their intended enclosures at 100 percent of continuous ampere rating. The circuit breakers shall include, where necessary, current-limiting fuses, integrally mounted, coordinated with the breaker trip device to avoid unnecessary blowing of the fuses. Breakers equipped with current-limiting fuses shall have an anti-single phase device that will trip the breaker in the event of a blown fuse, indicate on the front of the breaker which limiter is blown, and prevent the breaker from being reclosed on a single-phase condition due to missing or blown limiters. Breakers shall have stored energy operating mechanisms. Only one stroke of the operating handle shall be required to charge the stored energy spring when operating the breaker. The release of the energy to close the breaker shall be by means of a mechanical pushbutton to ensure positive control of the closing operation. Both main breakers and the tie breaker shall have key interlocking to prevent no more than two breakers from being closed simultaneously at any time.
    a. Each breaker shall be equipped with a microprocessor-based tripping device. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker.

       The trip unit shall be:

       1) Square D Micrologic 6.0 series.
       2) Eaton Digitrip 1150+ LSIG series.
       3) ABB SACE PR123/P series.
       4) General Electric, MicroVersaTrip Plus.
       5) Or Pre-Approved Equal.

    b. Arc Flash Reduction Module:

1) Provide arc flash reduction module on main breaker 1200 amperes and larger, with control switch and blue light both external to the breaker trip unit indicating in maintenance mode.
2) For systems that have an Arc Flash Reduction Module installed, there shall be a 1.75" x 5.75" phenolic placard installed, red in color with white font, stating to match Figure 2.2.D below.
3) Product and Manufacturer shall be BRADY, or equal.

THIS EQUIPMENT IS EQUIPPED WITH AN ARC FLASH REDUCTION MODULE:
Before performing energized electrical work on this equipment, the electrical distribution system shall be placed in the MAINTENANCE Mode "ON" position at the Switgear Main Circuit Breaker.
Please refer to manufacturer's procedures for switching this system to maintenance Mode "ON" position.

Figure 2.2.B

c. Each trip unit shall be capable of Modbus RS-485 communication.
d. Furnish a RS-485 Modbus-to-Modbus TCP Ethernet Gateway for translating Modbus protocol network communications into Ethernet for trip units to communicate to UCOS via Ethernet.

10. All control wire shall be No. 14 AWG minimum, Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals shall be provided integral to a device. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring, markers and wire numbers shall conform to Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables. The color coding of the wires shall be in accordance with NFPA 79.
11. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device.
12. Each compartment labeled as "SPACE" on the Drawings, shall be equipped provisions for a future, manually operated breaker of frame rating as shown on the Drawings. All breaker locations designated as "SPACE", "FUTURE", or "FUTURE SPACE" on the Drawings, shall be furnished with all necessary provisions for a future, manually operated circuit breaker.

C. Metering:
1. Provide power monitoring as specified in Section 26 09 13, Power Monitoring System.

D. Manufacturer's Nameplates:
1. Factory installed engraved manufacturer's nameplates, mounted on the face of the assembly, and shall be furnished for all main, tie and feeder breakers. These nameplates shall be laminated plastic with 1/2"-inch minimum, Arial, black characters on a white background or match existing, secured with stainless steel screws. These nameplates shall also contain item designation, equipment served, breaker frame size and breaker trip rating.

2. All control components within the assembly shall be identified in correspondence to appropriate designations on the manufacturer's wiring diagrams.

E. Accessories:
1. Portable, breaker lifting device for each lineup.
2. Portable test kit for testing and verification of trip units. Test kit shall operate on 120 VAC power from any outlet.
3. 10% spare fuses of each type and size in project.
4. Levering crank for moving the breaker between "TEST" and "CONNECTED" positions.
5. Test jumper for electrically operating the breaker while out of its compartment.
6. Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails.
7. One set of rail extensions and rail clamps.
8. Transfer truck (turning dolly) for removing and transporting circuit breakers.
9. Circuit breaker remote control station for opening and closing the circuit breaker with 50 ft. minimum cord and plug.
10. Remove circuit breaker racking mechanism. Cord and Plug should be 50 ft. minimum. Connection of the mechanism shall be made with the circuit breaker compartment door closed.
11. Any additional devices as required and as shown on the Drawings.

F. Infrared Window:
1. Provide infrared windows for viewing of the line and load side terminals of the main breaker(s).
   a. Size: 4 inch
   b. Window to be provided with a coating to seal the optic prior to assembly to protect against degradation.
   c. Window to be provided with hand turn door latch with identification plate.
   d. Mount window with high temperature silicon gaskets.
   e. Product and Manufacturer: Provide the following:
      1) Fluke ClirVu® CV Series

G. Product and Manufacturer: Provide one of the following:
1. PowerZone 4, as manufactured by Square "D" Company.
2. Magnum DS, as manufactured by Eaton.
3. ReliaGear LV SG, as manufactured by ABB.
4. Or Pre-Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance. Seal bottom of equipment with RTV silicone.

B. Install equipment on concrete pad, as shown on Drawings. Coordinate pad dimensions to fit equipment furnished.

C. Responsibility for all overcurrent protection settings as determined by Section 26 05 73, Power System Study, belongs to CONTRACTOR. The trip settings shown on the Drawings represent the desired long time pickup setting. Coordinate all protective device settings with the approved Power System Study submitted per Section 26 05 73.

D. Install in accordance with Phoenix Electrical Code.

3.2 FIELD INSPECTION AND TESTS

A. Provide the services of an authorized service representative of the equipment manufacturer to make site visits to supervise the field testing to be performed by CONTRACTOR. The service representative shall be an employee of the manu-facturer of the low voltage drawout switchgear. The manufacturer's representative shall provide certification to the OWNER that the equipment has been correctly installed and shall submit the factory and field test results to the OWNER. The manufacturer's representative shall certify, in writing, that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recom-mendations.

B. Perform the following minimum tests and checks before energizing equipment.
   1. Perform insulation resistance tests on each bus section, phase-to-phase and each phase-to-ground for a period of one minute at 2200 volts DC.
   2. After successful completion of insulation resistance test, perform an over-potential test on each bus section, each phase-to-ground for a period of one minute at manufacturer's recommended voltage.
   3. Inspect all mechanical and electrical interlocks for proper operation.
   4. Perform insulation resistance test on all control wiring at 1500 volts DC after disconnecting devices.

C. The manufacturer shall supply, upon request, test results to confirm that the switchgear assembly design has been tested to substantiate conformance with the applicable ANSI and NEMA Standards. The tests shall verify not only the performance of the switch or integrated switch and fuse, but also the suitability of the enclosure venting, rigidity and bus bracing. In addition, the switchgear assembly shall be factory tested in accordance with IEEE Standard C37.20.3 and the Contract Documents.

D. Perform any other tests recommended by the equipment manufacturer.

E. Electrical Acceptance Testing shall be done in accordance with the latest NETA ATS Standard.

F. Provide completed forms 26 05 01-H, Low Voltage Switchgear Test Form, in accordance with Section 01 33 10, Reference Forms.

G. The testing specified in paragraph above shall be performed by a certified lab under the direction of the manufacturer’s representative.

3.3 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of Four (4) visits, minimum Sixteen (16) hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the low voltage drawout switchgear conforms to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

3.4 FIELD ADJUSTMENTS

A. Relay settings on the microprocessor protective device shall be performed by CONTRACTOR in the field in accordance with the recommended settings designated in the coordination study in Section 26 05 73, Power System Study.

+ + END OF SECTION + +

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SECTION 26 24 10

LOW-VOLTAGE DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install free-standing, dead-front type low-voltage distribution switchboards, utilizing group mounted circuit protective devices as specified herein and as shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. NEMA PB-2
   2. UL Standard No. 891.
   3. National Fire Protection Association 79, Electrical Standards for Industrial Machinery.
   4. Phoenix Building Code.
   5. National Electrical Code (NEC) current adoption.
   6. City of Phoenix – Amendments to the National Electrical Code.

C. The manufacturer of the assembly shall be the manufacturer of the circuit protective devices within the assembly.

D. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

E. The switchboards shall be suitable for and certified to meet all applicable seismic requirements of the Phoenix Building Code, for Zone 2 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

   1. Manufacturer's technical information for low-voltage distribution switchboards and equipment proposed for use. NFPA 79, Annex "D" Standard elementary

and wiring diagrams shall be included. Shop Drawings shall include the following:

a. Master drawing index.
b. Front view elevation.
c. Floor plan.
d. Top view.
e. Single line.
f. Schematic diagram.
g. Manufacturer's nameplate schedule.
h. Component list.
i. Conduit entry/exit locations.
j. Assembly ratings including:
    1) Short-circuit rating.
    2) Voltage.
    3) Continuous current.
k. Major component ratings including:
    1) Voltage.
    2) Continuous current.
    3) Interrupting ratings.
l. Cable terminal sizes.
m. Certified production test reports.
n. Wiring diagrams.
o. Installation information, including seismic certification and equipment anchorage details.

B. Where applicable, the following additional information shall be submitted to the ENGINEER:
    1. Busway connection.
    2. Connection details between close-coupled assemblies.
    3. Composite floor plan of close-coupled assemblies.
    4. Key interlock scheme drawing and sequence of operations.

C. Operation and Maintenance Manuals:
    1. Submit complete installation, Operation and Maintenance Manuals, test reports, maintenance data and schedules, description of operation and spare parts information.
    2. Furnish Operations and Maintenance Manuals in conformance with requirements of Section 01 78 23, Operation and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

B. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

C. All boxes, crates and packages shall be inspected by the CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

D. Store materials to permit easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 RATINGS

A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as required at rated voltage.

B. Voltage rating shall be 480/277 volts, 3 phase, 3-wire (or 4 wire) as indicated on the Single Line Diagram.

2.2 CONSTRUCTION

A. Switchboards shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

B. All sections of the switchboard shall be rear aligned with depth as shown on the Drawings. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.

C. The low-voltage distribution switchboards shall be UL labeled.

D. Product and Manufacturer: Provide one of the following:
   1. ABB
   2. Square D
   3. Eaton
   4. Or equal.

2.3 BUS

A. All bus bars shall be tin-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside the enclosure).

B. Provide a full capacity neutral bus where a neutral bus is shown on the Drawings, unless otherwise specified.

C. A tin-plated copper ground bus (minimum 1/4 by 2-inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

2.4 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75°C of the size as shown on the Drawings.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as shown on the Drawings.

D. All control wire shall be Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminals blocks with suitable numbering strips. Provide wire markers at each end of all control wiring. The wires shall be color coded conforming to the requirements of NFPA 79.

2.5 MOLDED CASE PROTECTIVE DEVICES

A. Main breakers and feeder circuit breakers of 400 amp frame and above shall be molded case circuit breakers with microprocessor based trip unit which shall provide adjustable long time pickup and delay, adjustable short time pickup and delay, adjustable instantaneous and adjustable ground fault pickup and delay. The microprocessor trip unit shall be General Electric, MicroVersaTrip Plus, or equal. Interrupting rating shall be 65,000 amps symmetrical. Circuit breakers of 250 amp frame and below shall have thermal-magnetic trip units and inverse time characteristics.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity as shown on the Drawings.

D. Where indicated, circuit breakers shall be current limiting.

2.6 MISCELLANEOUS DEVICES

A. Control power transformers with primary and secondary protection shall be provided, as shown on the Drawings, or as required for serving space heaters.

B. Each section of the switchboard shall be provided with a thermostatically controlled space heater. Power for the space heaters shall be obtained from a control power transformer within the switchboard. Supply voltage shall be 120 VAC.

2.7 ENCLOSURES

A. NEMA 1.

2.8 MANUFACTURER'S NAMEPLATES

A. Manufacturer's Nameplates:
   1. Factory installed engraved manufacturer's nameplates, mounted on the face of the assembly, and shall be furnished for all main, tie and feeder breakers. These nameplates shall be laminated plastic with one-inch minimum, Arial, black characters on a white background or match existing, secured with stainless steel screws. These nameplates shall also contain item designation, equipment served breaker frame size and breaker trip rating.
   2. All control components within the assembly shall be identified in correspondence to appropriate designations on the manufacturer's wiring diagrams.

2.9 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
   1. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a

dielectric test of 2200 volts for one minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute between live parts and ground.

B. The manufacturer shall provide three certified copies of factory test reports.

3.2 INSTALLATION

A. Install all equipment in accordance with the manufacturer's recommendations and instructions, approved Shop Drawings and Phoenix Electrical Code.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to CONTRACTOR supplied floor sills to be set level in concrete in accordance with manufacturer's recommendations. All necessary hardware to secure the assembly in place shall be provided by CONTRACTOR.

3.3 FIELD ADJUSTMENTS

A. Perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.

B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by CONTRACTOR, at no additional cost to the OWNER.

3.4 MANUFACTURER'S CERTIFICATION

A. A certified test report of all standard production tests shall be available to the ENGINEER, upon request.

3.5 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of two (2) visits, minimum eight (8) hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the low-voltage distribution switchboards conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install lighting, instrumentation and distribution panelboards.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. NEC Article 408, Switchboards and Panelboards.
   2. NEMA PB1, Panelboards.
   3. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   4. UL Standard 50, Electrical Cabinets and Boxes.
   5. UL Standard 67, Electric Panelboards.
   6. UL Standard 698, Circuit Breaker Panelboard Assembly.
   7. UL Standard 943, Ground Fault Circuit Interrupters.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for panelboards proposed for use.
   2. Listing of the panelboards to be furnished with an identification of their proposed location, and number and rating of branch circuit breakers.
   3. Lighting, instrumentation and distribution panelboards load calculations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Panelboards:
   1. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles shall be as shown on the Drawings.
   2. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
   3. Main and branch circuit breakers shall be fully rated with interrupting capacities as follows:
      a. 65,000 amps for 480/277 volt circuit breakers.
      b. 22,000 amps for 120/240 volt circuit breakers.
   4. Bus Bars: 98 percent conductivity copper, tin plated. All 4 wire panelboards shall have a solid neutral bar. All panels shall have ground bus.

5. Main: All panelboards shall have a main circuit breaker, unless Drawings specifically call for main lugs only.
6. Branch circuit breakers connected for sequence phasing.
7. Construction: Code grade steel, NEMA 12, ample gutter space, flush door, flush snap latch and lock for dry indoor locations. NEMA 4X stainless steel for outdoor or damp indoor locations.
8. Trim: Surface or flush, as required.
9. Directory: White card, minimum card stack 90 lb., maximum size 8" x 5", placed in a 9" x 5 ½" self adhesive vinyl pocket. Directory information to be a copy of the as-built panel schedule as provided on the contract drawings.
10. Identification: Factory installed manufacturer's nameplate identifying the panel number and voltage.
11. Product and Manufacturer: Provide panelboards of one of the following:
    a. Square D Company.
    b. General Electric Company.
    c. Eaton
    d. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting: Install panelboards at locations shown on Drawings. Set cabinets so that top branch circuit breaker is not over six feet above the floor.

B. Arrange circuits to balance the loads on the panelboards.

+ + END OF SECTION + +

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SECTION 26 27 26.10

RECEPTACLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install receptacles.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix Electrical Code.
   2. UL Standard No. 1010, Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.
   3. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for receptacles proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Receptacles for Non-Hazardous Locations:
   1. Duplex grounding receptacle, two pole, three wire, 125 volt AC, 20 amperes.
      a. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 5362, for dry indoor locations and Catalog No. 53CM62, for wet and corrosive locations, by Harvey Hubbell Incorporated.
         2) Catalog No. 5362, for dry indoor locations and Catalog No. 5362-CR, for wet and corrosive locations, by Arrow-Hart Incorporated.
         3) Or equal.
   2. Single grounding receptacle, corrosion resistant, two pole, three wire, 125 volt AC, 20 amperes.
      a. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 53CM61, by Harvey Hubbell Incorporated.
         2) Catalog No. 5361-CR, by Arrow-Hart Incorporated.
         3) Or equal.

B. Receptacles for Hazardous Locations:
   1. Material: Factory sealed receptacle suitable for installation in Class I, Group D hazardous locations. Copper-free aluminum receptacle and cover with cast

gray iron alloy or cast malleable iron mounting box with zinc electroplate finish. Receptacle rated at 20 amperes, 125 to 250 volt AC, two pole, three wire. Provide matching plug for each receptacle.

2. Product and Manufacturer: Provide one of the following:
   a. Series CPS by Crouse-Hinds Company.
   b. Type CPS by Appleton Electric Company.
   c. Or equal.

C. Ground Fault Receptacles:
   1. Duplex receptacle, two pole, three wire, 125 volt AC, 20 amperes.
   2. If receptacles are installed outdoors, the receptacles must be rated Weather Resistant (WR) and must be marked as such on the receptacle itself with WR on the device.
   3. Product and Manufacturer: Provide one of the following:
      a. Catalog No. GF5362 or GFRS5326TR, by Harvey Hubbell Incorporated.
      b. Catalog No. TWRVGF20x, Cooper Wiring Devices

D. Surge Suppression Receptacles:
   1. Duplex grounding, surge suppression receptacle, two pole, three wire, 125 volt AC, 20 amperes, capable of absorbing a transient surge 6,000 volts minimum. Receptacle to include power on indicator light:
      a. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 5350S by Harvey Hubbell Inc.
         2) Catalog No. 5380-GY by Leviton Manufacturing Company.

E. Power Receptacles: 480 volt interlocked receptacle with enclosed safety switch service outlet: Provide service outlets, quantity as shown on the Drawings for portable equipment.
   1. Material: Copper free aluminum enclosure with operating handle NEMA 4, with gasketed hinged door.
   2. Switch: Heavy duty, three pole, with visible blades, a quick make a break mechanism with reinforced, positive pressure type blade and fuse clips. Switch shall be mechanically interlocked with the receptacle. The switch cannot be closed until the plug is fully inserted and the plug cannot be withdrawn or inserted, unless the switch is open.
   3. Receptacle: Single ground receptacle, three wire, four pole, 600 volt, 60 amp. Provide two matching plugs.
      a. Type WSR, and Type APS plugs by Crouse-Hinds Company.

F. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown on the Drawings. Coordinate with equipment plugs. Provide matching plug for each receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install receptacles at locations as shown on the Drawings in outlet or device boxes in accordance with Section 26 05 33.18, Outlet Boxes, in non-hazardous locations.

B. Install receptacles in PVC coated galvanized rigid steel conduit systems in hazardous locations.
C. Install receptacles with ground pole in the down position.

D. Mount receptacles 18-inches above finished floor, or in accordance with Phoenix Building Code, in non-hazardous locations and 4 feet-6 inches above finished floor in hazardous locations, unless otherwise noted.

E. Identify each conductor with the circuit number and the lighting panel number. Identification shall conform to the requirements of Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.

F. Identify each receptacle with a permanent self adhesive label. Approximate size 3/8" x 1¼". The label shall include the panel name and circuit number.
    a. Product and Manufacturer: Provide one of the following:
        1) Catalog No. PTL-45422 by Brady.
        2) Or Equal

G. Install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 26 27 26.15

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install snap switches for lighting and other systems.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. National Electrical Code (NEC) current adoption.
   2. City of Phoenix – Amendments to the National Electrical Code.
   3. UL Standard No. 20, General Use Snap Switches.
   4. UL Standard No. 894, Switches for Use in Hazardous Locations.
   5. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches for Non-Hazardous Locations:
   1. Single pole AC toggle switch, quiet type, 120/277 volt AC, 20 amperes, Ivory, specification grade. Switches supplying motors shall be HP rated.
      a. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 1221-I, by Harvey Hubbel Incorporated.
         2) Catalog No. 1991-I, by Arrow-Hart Incorporated.
   2. Single pole, 3-way AC toggle switch, quiet type, 120/277 volt AC, 20 amperes, Ivory, specification grade. Switches supplying motors shall be HP rated.
      a. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 1223-I, by Harvey Hubbell Incorporated.
         2) Catalog No. 1993-I, by Arrow-Hart Incorporated.
   3. Two pole AC toggle switch, quiet type, 120/277 volt AC, 20 amperes, Ivory, specification grade. Switches supplying motors shall be HP rated.
      a. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 1222-I, by Harvey Hubbel Incorporated.
         2) Catalog No. 1992-I, by Arrow-Hart Incorporated.

B. Switches for Hazardous Locations:
   1. Material: Factory sealed tumbler switch suitable for installation in Class I, Group D hazardous locations. Cast gray iron alloy or cast malleable iron body and cover with zinc electroplate finish. Switch rated at 20 amperes, 120/277 volt AC. Switches supplying motors shall be HP rated.
   2. Product and Manufacturer: Provide one of the following:
      a. Series EDS by Crouse-Hinds Company.
      b. Type EDS by Appleton Electric Company.

C. Switch Covers:
   1. Indoor covers shall be Type 304, stainless steel.
   2. Outdoor or wet location covers shall be weatherproof and corrosion resistant.

D. Key Operated On-Off Switches:
   1. Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two keys for each switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switches at locations as shown on the Drawings in outlet or device boxes in accordance with Section 26 05 33.18, Outlet Boxes, in non-hazardous locations.

B. Install switches in PVC coated galvanized rigid steel conduit systems in hazardous locations.

C. Mount wall switches 4 feet-6 inches above finished floor or in accordance with Phoenix Construction Code, unless otherwise noted.

D. Identify each conductor with the circuit number and the lighting panel number. Identification shall conform to the requirements of Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.

E. Install switches in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 26 28 15

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install disconnect switches.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) current adoption.
   2. City of Phoenix – Amendments to the National Electrical Code.
   3. UL Standard No. 98, Enclosed Switches.
   4. NEMA KS-1, Enclosed Switches.
   5. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for disconnect switches proposed for use.
   2. Snap Switches (for disconnect switches on 120 volt, single phase circuits) coordinate with Section 26 27 26.15.
   3. Listing of the switches to be furnished with an identification of their location, rating and NEMA enclosure type.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Service Disconnect Switches:
   1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in OFF position and safety handle.
   2. Rating: Voltage, current and short circuit ratings and number of poles as shown on the Drawings. Switch shall bear a UL label certifying suitability for use as service equipment.
   3. Provide auxiliary dry contacts to indicate switch position.
   4. Disconnect switch to be rated for the available fault current.

B. Single Throw, Circuit Disconnect Switches:
   1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.

2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label.
3. Provide auxiliary dry contacts to indicate switch position.
4. Disconnect switch to be rated for the available fault current.

C. Double Throw Safety Switches:
1. Type: Unfused, double throw with center OFF position, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
2. Rating: Voltage and current ratings and number of poles as required for the circuits being disconnected.
3. Provide auxiliary dry contacts to indicate switch position.
4. Disconnect switch to be rated for the available fault current.

D. Enclosures:
1. NEMA 12 for dry, indoor non-corrosive areas.
2. In all other locations except wet or corrosive, NEMA 4X 304 stainless steel. For wet or corrosive locations, NEMA 4X 316 stainless steel.
3. NEMA 7 for explosion proof areas.

E. Identification:
1. Identify all enclosures in accordance with Section 26 05 01, General Provisions.
2. Manufacturer's nameplates identifying equipment, include identification of the equipment served and source of power, for which switches serve as the disconnecting means. Manufacturer's nameplates shall be permanently fastened to enclosures.
3. Comply with the requirements of Section 01 93 13.15, Computerized Maintenance Management System Tags.

F. Product and Manufacturer: Provide one of the following:
1. Square D.
2. ABB.
3. Eaton.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists.

C. Furnish one set of spare fuses for each fused disconnect switch to be installed.

D. Install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 26 29 13.15

CONTROL STATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install pushbuttons, selector switches and other control stations.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. NEMA Standard ICS2-216, Pushbuttons, Selector Switches, Indicating Lights and Pushbutton Stations.
   2. National Electrical Code (NEC) current adoption.
   3. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for control stations proposed for use.

B. Control stations shall be furnished in accordance with the requirements as shown on the Drawings, and as specified in Division 40, Sections 40 61 96, 40 70 00, 40 06 70, and 40 61 93.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Control Stations:
   1. Type: Industrial, heavy duty, oil tight construction with clearly marked Type 316 stainless steel or non-metallic material nameplates identifying equipment controlled.
   2. Enclosures: NEMA 12 for dry indoor locations, NEMA 4X for outdoor and damp, wet or corrosive indoor locations. NEMA 4X stations shall be stainless steel and shall have locking rings, nameplates and all external hardware and components shall be Type 316 stainless steel or non-metallic material.
   3. Emergency Stop: Maintained contact type, NEMA A600 contact rating, color red with clearly marked Type 316 stainless steel or non-metallic material nameplate identifying equipment operation, provide as shown on drawings.

4. Pushbuttons: Momentary contact types, NEMA A600 contact rating, with clearly marked Type 316 stainless steel or non-metallic material nameplate identifying equipment operation, provide as shown on drawings.
   a. Stop: Boot color to be red.
   b. Start: Boot color to be black.
5. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both to a maintained position with clearly marked Type 316 stainless steel or non-metallic material nameplate identifying equipment operation, provide as shown on drawings.
6. Indicating Lights: 120 VAC, Push-To-Test. Lens color red for running, green for stopped or ready and amber for failure with clearly marked Type 316 stainless steel or non-metallic material nameplate identifying equipment operation, provide as shown on drawings.
7. Product and Manufacturer: Provide control stations of one of the following:
   a. Square D Company.
   b. General Electric Company.
   c. Allen Bradley Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment, as shown on the Drawings, so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which they are mounted. Provide independent stainless steel or FRP supports where no wall or other surface exists.

C. Install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 26 32 13.10

480 VOLT STANDBY POWER GENERATOR SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as required to furnish and install one (1), diesel engine-generator sets complete with all appurtenances as shown on the Drawings, specified and required for complete operational diesel engine generator standby power systems where required by the Drawings.

B. In order to centralize responsibility, it is required that the entire engine generator and all equipment and services provided under this Section be furnished by a single supplier or manufacturer who shall assume full responsibility for the completeness of the systems. The supplier shall be authorized to perform warranty service on the complete system.

C. The manufacturer of the equipment specified herein shall be required to review and satisfy all relevant requirements of other Sections of the Contract Documents.

D. Warranty: The equipment supplied under this Section shall be covered by a single warranty against defects in material and workmanship for a period of five years or 3000 hours of operation. Warranty shall provide for free replacement or repair of parts for the five years or 3000 hours of operation period, and free labor for the first two years. A warranty statement including these features shall be provided as part of the OWNER'S operation and maintenance manuals. Warranty shall be administered by the same company that supplied the equipment.

E. Electrical connections will be furnished by CONTRACTOR.

F. The equipment will be installed by CONTRACTOR.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. The manufacturer shall have complete parts and service facilities and a factory trained service staff available on a 24-hour basis.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:

1. Local Ordinances: The manufacturer shall submit proof that the engine generator sets meet all requirements with respect to noise control and emission. Exhaust emissions and sound levels shall not exceed the values given under Products, in this Section. Certified test reports shall be provided.
2. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
3. Phoenix Building Code.
4. Underwriters' Laboratories Incorporated (UL).
5. National Fire Protection Association (NFPA).
6. National Electrical Code (NEC) current adoption.
7. City of Phoenix – Amendments to the National Electrical Code.

D. Source Quality Control:
1. All equipment shall be new, of current domestic production of a national firm which manufactures the engine-generator set as a matched unit, and the manufacturer together with its authorized representative, shall have full responsibility for the performance of the generator set and its accessories. Unit shall be designed for outdoor installation.
2. The engine generator set shall be factory assembled and tested to determine that it is free from electrical or mechanical defects and that it meets design specifications.
3. Supplier shall maintain a parts and service facility, employ factory trained technicians, and offer 24-hour emergency service. Supplier shall be the authorized dealer of the manufacturer offering standard production equipment built and prototype tested in accordance with NFPA 110, and shall be authorized to administer the warranty for all components of the standby generator system specified herein.
4. UL inspection and labeling.
5. Perform the following tests and inspections at factory.
    a. Pressure test at five psi.
    b. UL inspection and labeling.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. Air Pollution Control District Rules and Regulations.
2. EGSA 100C, Performance Standard: Battery Chargers for Engine Starting and Control Batteries, 1992 Edition.
3. EGSA 100E, Performance Standards for Governors on Engine Generator Sets, 1984 Edition.
4. EGSA 100F, Performance Standard for Engine Protection Systems, 1992 Edition.
5. EGSA 100G, Performance Standard for Generator Set Instrumentation, Control and Auxiliary Equipment, 1980 Edition.
6. EGSA 100R, Performance Standard for Voltage Regulators Used on Electric Generators, 1992 Edition.
7. Electrical Generating Systems Association (EGSA) 100B, Performance Standard for Engine Cranking Batteries for Use With Engine Generator Sets, 1992 Edition.
8. IEEE Std 126-1959/83, Speed Governing of Internal Combustion Engine-Generator Units.

9. NFPA 30, Flammable and Combustible Liquids.
10. NFPA 31, Standard for the Installation of Oil-Burning Equipment.
11. NFPA 37, Standard for the Installation and use of Stationary Combustion Engines and Gas Turbines.
12. NFPA 70E Electrical Safety Requirements for Employee Workplaces, 1988 Edition.
13. NFPA 99 Health Care Facilities, 1993 Edition.
14. NFPA 101 Life Safety Code, 1991 Edition.
15. NFPA 110 Emergency and Standby Power Systems, 1993 Edition.
16. Phoenix Electrical Code, Article 701, Legally Required Standby Systems.
17. NEMA MG1, Motors and Generators.
18. UL Standard No. 1008 Standard For Safety.
19. UL Standard No. 142 Steel Above Ground Tanks.
20. UL Standard No. 2085, Insulated Aboveground Tank for Flammable and Combustible Liquids.
21. ULC/ORD 142.23, Aboveground Waste Oil Tank.
22. ULC/ORD 142.5, Aboveground Concrete Encased Steel Tank Assemblies.

F. Performance Tests:
1. Factory Tests: Standard production tests shall be performed at the factory after assembly to verify proper operation and performance. CONTRACTOR notify the OWNER and ENGINEER at least two weeks in advance of the test.
2. The equipment supplied shall have been prototype tested and reports shall be provided with the submittals.
3. Field testing shall be performed by a factory trained serviceman as coordinated by CONTRACTOR.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Standby power generators.
a. Bill of Material, covering all equipment submitted.
b. Qualifications of the engine-generator manufacturer and of the authorized distributor in accordance with Paragraph 1.2.A of this Section. Verify the availability of 24-Hour emergency service capability.
c. Manufacturer's published rating sheet. NFPA-110 test verification. Altitude and temperature derating procedures. Frequency and voltage regulation. Cooling system capability. Full rated load pickup capability.
d. Installation requirements: Radiator airflow and backpressure capacity, combustion air requirement, fuel consumption, fuel circulation, heat rejection, exhaust flow, exhaust back-pressure calculations, battery requirements. ISO container pad layout dimensional data with provision for cable entry and termination.
e. Engine performance data. Configuration, cubic inch displacement, rated RPM, type of aspiration, voltage of electrical system, oil and coolant capacities, exhaust volume and temperature, and motor starting capability in KVA at 90 percent sustained voltage.
f. Exhaust emission data provided on the current application form of the Air Pollution Control District (APCD). Exhaust and crankcase emission control equipment devices.

g. Description of battery set and battery charger.
h. Generator data sheet including, as a minimum, design type, continuous and standby rating in KW, voltage, phase, frequency, winding insulation class and temperature rise, coupling, voltage and frequency regulation capability, AC wave form total harmonic distortion from no load to full linear load and surge KW capacity.
i. Control panel features and performance. Meters and gauges. Safety alarm and shutdown devices. Cranking control. Indicator lamps and horn. Control switches.
j. Exhaust silencer attenuation rating.
k. Jacket water heater system.
l. Generator control panel front views, wiring diagrams, instrument and relay data, description of operation.
m. Generator set seismic restraint devices.
    1) Agency pre-qualification.
    2) Dimensional data.
    3) Seismic restraint calculations.
n. Enclosure details.
    1) Exhaust system mounting.
    2) Overall dimensions.
    3) Sound attenuation data for conformance to specified requirements and to APCD requirements.
o. Fuel storage system.
    1) Compliance with UL.
    2) Secondary containment.
    3) Alarm and indicator devices.
    4) Dimensional data.
    5) Fuel capacity and hours of operation at rated load.
    6) Seismic restraint devices and calculations for the fuel tank configuration.
p. Schematic and wiring diagrams for all major components. Interconnection diagram for all major components.
q. Complete details of generator enclosure.
r. Shop and field testing procedures.
s. Warranty certificate and administration authorization by the supplier in accordance with Paragraph 1.1.E., above.
t. Complete the Reference Form 26 32 13.10-A - “Add Generator to Fleet – Inspection Checklist” as provided in Section 01 33 10 – Reference Forms.

2. Above-ground fuel oil storage tank.
    a. Manufacturer’s literature, illustrations, specifications, engineering data, materials of construction, dimensions, and cross-section cuts.
    b. Drawings showing fabrication methods, assembly, installation details, and accessories including construction of tank, piping layouts, calibration charts, and sizing of all fittings.
    c. Piping sump details, dimensions, including installation details.

B. Operation and Maintenance Manuals:
    1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.

2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following generator sets are required:
   1. Number Required: One (1).
   2. Ratings:
      a. Refer to contract drawings for generator size, 0.8 power factor, 480 volts, 3 phase, 4 wire, 60 Hz. when equipped with all accessories. Ratings are based on standby operation.
   3. Cooling System: Radiator type, unit mounted.

B. Ambient Conditions:
   1. Maximum Ambient Temperature: 50°C.
   2. Altitude: 1000 feet above sea level.

2.2 ENGINE-GENERATOR SET

A. Engine Type: Four cycle, radiator cooled diesel, 1800 RPM, maximum bore-to-stroke ratio of unity and maximum crankshaft operating speed of 1800 RPM. Two cycle engines are not acceptable.

B. Engine Construction:
   1. Steel backed bearings.
   2. Crank Case: Reinforced cast iron.
   3. Crank Shaft: Forged alloy steel with hardened journals, finished and dynamically balanced.
   4. Cylinder Head: Cast iron.
   5. Pistons: Aluminum alloy with chrome faced rings.
   6. Replaceable cylinder liners and valve seat inserts for engines rated over 200 horsepower.
   7. Single block construction. Bolted, multiple blocks are not acceptable.

C. Cooling System:
   1. Cooling system shall employ an engine-mounted radiator capable of cooling the engine when operating under full load conditions in an ambient temperature of 50°C.
   2. Engine shall be provided with a thermostatic valve placed in the jacket water outlet between the radiator and the engine to maintain proper jacket water temperature. An integral engine driven circulating pump shall be provided to circulate water through the engine cooling system.
   3. Coolant: System shall be filled with a 50 percent solution of ethylene glycol.
   4. High engine temperature shutdown.
   5. Loss of coolant shutdown.
   6. Engine coolant heaters, thermostatically controlled capable of keeping the jacket water at a minimum temperature of 90°F in an ambient temperature of 20°F. The coolant heaters shall operate at **208 volts**, single phase. Provide a suitably rated contactor and control transformer for controlling the jacket water heater, in a NEMA 4X, stainless steel box, mounted on unit.
   7. The radiator shall include duct adaptors for the connection of radiator discharge ducting.

D. Lubrication System: Force feed to all bearings with integral gear type pump, full-flow filters, oil level indicator, 480 volt, single phase, oil pan heater, oil temperature and pressure gages. System shall include main lube oil pump. Oil pan heater shall be complete with contactor in NEMA 4X, stainless steel enclosure mounted on unit. The oil pan heater shall be controlled by the coolant heater thermostat.

E. Fuel System: Suitable for operation on No. 2 diesel fuel oil. System to include fuel filters, fuel pump, dry element air cleaners, an electronic governor and the following:
   1. Governor: Electronic, speed droop externally adjustable, isochronous to five percent.
   2. Fuel/Water Separator.

F. Fuel Oil Day Tank System:
   1. The fuel day tank shall have the capacity to hold 24 hours of fuel with the engine generator set operating at full load, shall be heavy gauge steel, with removable inspection plate, 6-inches square and fully gasketed.
   2. The day tank shall have a fuel level gauge and a heavy-duty float switch "pump running" indicator light.
   3. A pump "RUN/OFF/AUTOMATIC", three-position selector switch with includes a pilot light indicating power available.
   4. The day tank shall be equipped with a critical low fuel alarm-engine shut down with a separate float activates a light on the control panel providing a signal for remote annunciator, that will prevent loss of engine fuel prime.
   5. The day tank shall have a "HIGH/LOW" combination fuel level alarm. Separate dual float switch that activates red lights on the control panel.
   6. Tank shall come complete with four 1-inch threaded connections, tank drain and one 2-inch NPT threaded pipe connection for venting, plus the fuel inlet.
   7. A heavy duty 1/2 HP, 115 VAC, 1 phase, 60 Hz, motor with overload protection and a two gallon per minute bronze gear pump complete with stainless steel

shafts. The tank shall have a epoxy coated interior and the exterior painted with a medium gray or as directed by the ENGINEER.

8. The day tank shall have all plumbing and wiring pre-connected.
9. The fuel oil day tank shall comply with NFPA 30, pressure tested to five PSI for No. 2 diesel fuel.
10. Product and Manufacturer: Provide one of the following:
    a. Pryco, Inc.
    b. Or equal.

G. Exhaust System: Flexible stainless steel exhaust connectors and hospital critical silencing mufflers, GT exhaust systems, or equal as shown on the Drawings. Include condensate drain valve. All piping and mufflers shall be installed and insulated by CONTRACTOR. Back pressure shall not exceed 20-inches of water.

H. Starting System: DC system complete with engine mounted batteries, locally mounted charger and connecting cables between batteries and engine and between charger and batteries.
1. Batteries: Lead-acid or nickel-cadmium, engine cranking type, rated in accordance with engine manufacturer's requirements for a minimum of three 15 second cranking cycles at firing speeds without recharging. Batteries to be sized to accommodate DC power requirements of the control panel and any other accessories requiring DC power.
2. Engine mounted alternator, rated 75 amps minimum.
3. Charger: Automatic float charger, current limited, with DC ammeter and voltmeter, equalizing switch and capable of recharging the batteries to full charge in not more than six hours after three crank cycles, La Marche, rated 20 amps minimum, or equal. The charger shall be integrally mounted on the engine-generator set or wall and operate on 120 volts AC input.

I. Generator: Revolving field, 4-pole, brushless excitation, 2/3 pitch, open drip-proof self ventilated enclosure, Class H insulation, output blocking diode, skewed stator, dynamically balanced rotor, full amortisseur windings, epoxy coating on rotor and stator for abrasion and humidity protection, microprocessor controlled voltage regulator and anti-condensation heater. The alternator shall have the following characteristics:
1. Voltage Regulation: One percent from no load to full load.
2. Voltage Adjustment: Five percent in generator control panel.
3. Voltage Wave Form Deviation: In accordance with the requirements of NEMA MG1-22.43.
4. Telephone Influence Factor: In accordance with the requirements of NEMA MG1-22.43.
5. Excitation: Include a permanent magnet pilot exciter, in addition to the standard exciter, to sustain fault current to three times full load rating.
6. Rated for 80°C temperature rise.
7. The generator shall incorporate resistance temperature detectors (RTD’s) to monitor a minimum of six temperature zones, covering all three phases, in the generator windings. The RTD’s shall connect to a relay which determines the sensed temperature and acts to isolate, alarm or initiate corrective action, or provide dry contact output. RTD operational setpoint shall be 160°C.

J. Control Panel: Panel shall be furnished generator set mounted and shall contain the controls, instruments, lights, and other devices necessary to manually and automatically start, stop and protect the diesel engine-generator unit. Controls and alarms shall operate from battery power. The panel shall be mounted on vibration isolators. Panel installed in the interior of walk-in enclosures to be rated NEMA 12. All signals and alarms listed below shall be monitored by the CCS. Panel shall include the following:
   1. "RUN/OFF/AUTO" selector switch with terminals for two-wire remote start-stop signal from one or more automatic transfer switches.
   2. AC Volts, two percent accuracy, in percent of rated.
   3. AC amps, two percent accuracy, in percent of rated.
   4. VM/AM phase selector switch.
   5. Kilowatts, in percent of rated.
   6. Frequency, 0.5 percent accuracy.
   7. DC voltage readout.
   8. Engine coolant temperature readout.
   9. Engine oil pressure readout.
   10. Running time readout.
   11. Readouts and dry contact outputs for the following conditions:
      a. Overcrank (Shut Down).
      b. High coolant temperature (Warning Alarm).
      c. High high coolant temperature (Shut Down).
      d. Low coolant temperature (Warning Alarm).
      e. Low oil pressure (Warning Alarm).
      f. Low low oil pressure (Shut Down).
      g. High generator temperature (Warning Alarm).
      h. Low fuel level day tank (Warning Alarm).
      i. Battery voltage low (Warning Alarm).
      j. Battery voltage high (Warning Alarm).
      k. Generator running.
      l. Overspeed (Shut Down).
      m. Anticipatory low oil pressure (Warning Alarm).
      n. Anticipatory high water temperature (Warning Alarm).
      o. Manual emergency stop (Shut Down).
      p. Not in automatic (Warning Alarm).
      q. System ready.
      r. Battery charger fault (Warning Alarm).
      s. High high generator temperature (Shut Down).
      t. Low fuel level storage tank (Warning Alarm).
      u. Liquid in diesel fuel containment basin. This signal shall also be retransmitted to a remote panel.
      v. Battery weak at time of cranking (Warning Alarm).
      w. Overcurrent (Warning Alarm).
      x. Overcurrent (Shut Down).
      y. High AC voltage (Shut Down).
      z. Low AC voltage (Shut Down).
      aa. Under frequency (Shut Down).
      bb. Ground fault (Shut Down).
   12. Lamp test momentary push button controls and wiring.

13. Provide individual dry contacts closing on alarm for remote alarm for following conditions:
    a. Low oil pressure.
    b. High temperature.
    c. Generator winding high temperature.
14. Reset Control: Manual or remote restarts shall not be permitted and alarm lamps shall remain in the alarm state until manual reset is accomplished even if the alarm condition has been corrected.
15. Emergency stop pushbutton switch for shutdown independent of cooldown timer.
16. Cooldown timer.
17. Main circuit breaker, rated as shown on the Drawings (100% rated and rated for 100kAIC).
18. The following output signals shall be provided for interfacing with the CCS:
    a. Generator running.
    b. Generator common warning alarm.
    c. Generator common shutdown.
    d. Load shed signal.

K. Engine Generator Set Control:
1. The control shall have automatic remote start capability. The panel mounted switch shall stop the engine in the "STOP" position, start and run the engine in the "RUN" (unloaded) position, and allow the engine to start and run by closing a remote contact, and stop by opening the remote contact when in the "AUTO" position. In the "AUTO" position, one or more automatic transfer switches shall signal the engine generator to start upon loss of normal (utility) power. After the generator reaches approximately 90 percent of rated voltage, the automatic transfer switch shall transfer to the emergency position after a preset time delay.
2. The control shall include a cycle cranking function. The cranking cycle, nonadjustable shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration. Cranking shall cease upon engine starting and running. Two means of cranking termination shall be provided, one as a backup to the other. Failure to start after three cranking cycles (75 second) shall shut down and lock out the engine, and visually indicate an overcrank shutdown on the panel.
3. A solid-state time delay stop, adjustable from one to five minutes (factory set at five minutes), shall maintain the availability of the emergency source in the event that the normal power source fails shortly after retransfer and shall permit the engine-generator set to run unloaded for a cooldown period prior to shutdown.

L. Generator Base:
1. Base shall be a structural steel frame of adequate rigidity for generator and engine alignment.

M. Engine-Generator Set Mounting:
1. Vibration Isolators: Steel springs in combination with rubber pads. Korfund #LKD-D56H, 12 per set, or equal.

2. Anchor Bolts: Type 316 stainless steel conforming to the requirements of Section 05 05 19, Anchor Bolts, Toggle Bolts and Concrete Inserts.
3. A template shall be furnished by the manufacturer for setting anchor bolts, pipe sleeves, and nuts for mounting the spring type isolators specified to the concrete foundation. Bolts and nuts shall be furnished for bolting the isolators to the channel frame base of the engine-generator set.

N. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, conduit containing power or control cables and other externally connected support systems.

O. Manufacturer Nameplate: In accordance with the requirements of NEMA MG1-22.61.

P. Exhaust characteristics shall be furnished for compliance with Air Pollution Control District (APCD) regulations. Certified test reports shall be furnished for approval by the Air Pollution Control District and for the ENGINEER'S information.

Q. The sound pressure level developed by the generator set shall be a maximum 75 dBA at three feet when measured in accordance with IEEE Standard 85, Test Procedure for Airborne Sound Measurement on rotating electrical machines.

R. Spare Parts:
1. Provide the following spare parts for each generator set:
   a. Two sets - fuel filters (primary and secondary).
   b. One set - air filters.
   c. One dozen - light bulbs for control panel monitor lights.
   d. Two - fuses for control circuit.
   e. Two sets - lube oil filters.
   f. One set - fan belts.
   g. One set – upper and lower radiator hoses.
2. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project. Comply with the requirements of Section 01 78 43, Spare Parts and Maintenance Materials.

S. Product and Manufacturer: Provide one of the following:
1. Onan Corporation.
2. Caterpillar.

2.3 SURFACE PREPARATION AND PAINTING

A. Standby generator set, all ferrous metals of the equipment, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09 90 00, Painting and Coating. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

C. All surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09 90 00, Painting and Coating..

PART 3 - EXECUTION

3.1 INSTALLATION

A. Engine-Generator Set Mounting:
   1. Vibration Isolators: Steel springs in combination with rubber pads. Korfund #LKD-56H, 12 per set, or equal.
   2. Anchor Bolts: Type 316 stainless steel.
   3. A template shall be furnished by the manufacturer for setting anchor bolts, pipe sleeves, and nuts for mounting the spring type isolators specified to the concrete foundation. Bolts and nuts shall be furnished for bolting the isolators to the channel frame base of the engine-generator set.
   4. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, conduit containing power or control cables and other externally connected support systems.

B. Load test each generator, utilizing a resistive load bank if necessary, as follows:
   1. 1/2 hour at half load.
   2. 1/2 hour at 3/4 load.
   3. Four hours at rated full load.

3.2 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of three (3) visits, minimum eight (8) hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the standby power generators conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 26 33 53

STATIC UNINTERRUPTABLE POWER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install Uninterruptible Power Systems (UPS).

B. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to, Work that is directly related to this Section.
   1. Section 26 05 01, General Provisions.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   2. UL Standard 50, Electrical Cabinets and Boxes.
   3. UL Standard 67, Electric Panelboards.
   4. UL Standard 698, Circuit Breaker Panelboard Assembly.
   5. UL Standard 943, Ground Fault Circuit Interrupters.
   6. UL Standard 1449, Uninterruptible Power Systems.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for UPS proposed for use.
   2. Listing of the UPS to be furnished with an identification of their proposed location, and number and size of UPS.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Uninterruptible Power System:
   1. Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.
   2. UPS shall be comprised of a static inverter, a precision hysteresis loop battery charger, sealed maintenance free batteries, a relay and bypass switch shall be contained in a single package.

3. Under normal operating conditions, the critical load shall be powered by normal AC line supply that has been filtered through a ferroresonant transformer. When AC line power is present, the inverter shall be normally off.
4. When AC line power fails, the inverter shall supply AC power to the transformer from the battery source. There shall be no break in the output of the system during transfer from normal AC line supply to inverter battery supply or back to line. A single switch shall turn the system on and off. There shall also be an audible alarm disconnect switch.
5. Output capacity shall be provided to meet the load of equipment furnished and include the following requirements.
   a. Backup Run Time: 15 min at full load
   b. Input Voltage: as required VAC, Output Voltage: as required VAC.
   c. Voltage Regulation: ± Three percent nominal regulation.
   d. Efficiency: 85 percent on line at full load, 81 percent on inverter at full load.
   e. Wave Shape: Computer grade sine wave. Less than five percent THD.
   f. Frequency: 60 Hz ± 0.5 Hz.
   g. Noise Rejection: Common mode better than 120 dB. Transverse mode better than 60 dB.
   h. Isolation: Complete isolation from line with less than two pf of effective capacitance.
   i. Operating Temperature: 32 deg F to +104 deg F.
   j. Size: 5 kW minimum
6. Product and Manufacturer: Provide one of the following:
   a. Falcon.
   b. Eaton/Powerware, Incorporated.
   c. Or Pre-Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting: Install UPS at locations shown on Drawings.

+ + END OF SECTION + +

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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install automatic transfer switches complete and operational.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. UL Standard No. 1008, Automatic Transfer Switches.
   2. NEMA 1CS2-447, AC Automatic Transfer Switches.
   3. NEMA 1CS1-109, Tests and Procedures.
   4. IEEE Standard 472-1974, Guide for Surge Withstand Capability Tests.
   5. National Electrical Code (NEC) current adoption.
   6. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for automatic transfer switches proposed for use.
   2. Listing of the transfer switches to be furnished with ratings.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rating:

1. Switches shall be capable of switching all classes of loads and shall be rated for continuous duty when installed in a non-ventilated enclosure.
2. Switches shall be four pole with overlapping neutral, 480 volts with ampere rating as shown on the Drawings.
3. Switches shall have the same withstand rating as the service entranceat 480 volts.
4. All control wiring shall be Type SIS, rated for 600 volts. All control wire terminations shall be identified with tubular, sleeve-type markers.
5. Switches shall be enclosed in a freestanding, NEMA 12, non walk-in enclosure or integrally mounted in motor control centers as shown on the Drawings. Enclosures shall have a hinged and latched, gasketed door.
6. The transfer switch shall be rated for 100kAIC unless specifically indicated otherwise on the Single Line Diagram.

B. Operation:
1. Switches shall be double throw and operated by one, non-fused, momentarily energized operating mechanism with a minimum transfer time of 400 milli-seconds.
2. Operating mechanism shall prevent a sustained neutral position.
3. Normal and standby contacts mechanically and electrically interlocked to prevent simultaneous closing.
4. Mechanical locking of main contacts in each direction shall be accomplished without the aid of latching solenoids, toggle mechanisms or gear arrangements.
5. An overload or short-circuit shall not cause the switch to go to a neutral position.
6. Inspection of all movable and stationary contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The maintenance handle shall permit the operator to stop the contacts at any point throughout the entire travel to properly inspect and service the contacts when required.

C. Accessories: An integrally mounted control panel with adjustable solid-state or programmable microprocessor sensing and timing functions shall provide the following operational characteristics:
1. Time delay on momentary dips in normal source (0.5 to 6.0 seconds), factory set at one second.
2. Time delay on transfer to emergency for controlled loading of generator (0 to 1 minute), factory set at 0 minutes.
3. Time delay on retransfer to normal (0 to 30 minutes), factory set at 30 minutes.
4. Time delay on engine shutdown after retransfer to normal (0 to 5 minutes), factory set at five minutes.
5. Close differential voltage sensing of all normal source phases (pickup adjustable from 85 to 100 percent of nominal and dropout adjustable from 75 to 98 percent of pickup), factory set to pickup at 90 percent and dropout at 85 percent of nominal.
6. Independent voltage (85 to 100 percent pickup) and frequency (90 to 100 percent pickup), sensing of the emergency source to prevent premature transfer, factory set to pickup at 90 percent of nominal voltage and 95 percent of nominal frequency.
7. Test switch (momentary type) to simulate failure of normal source.

8. Two sets of gold-plated single pole, double throw contacts, which operate when the normal source fails. One set to be used for engine starting and the second set to be spare.
9. Pilot lights to indicate switch position.
10. Auxiliary contacts (two closed on "NORMAL" and two closed on "EMERGENCY") rated ten amps, 120 VAC. Additional auxiliary contacts as shown on the Drawings.
11. All time delay and sensing functions shall be field adjustable over the ranges indicated and shall operate with minimum drift (not to exceed ± one percent of set frequency, ± two percent of set voltage, and ± ten percent of set time delay) over the temperature range of -20°C to +70°C. The control panel shall be provided with a protective cover and an isolation plug in the wiring harness to disconnect all the control wires between the control panel and the main transfer panel.
12. Plant exerciser to automatically exercise generator. Exerciser shall be adjustable type with minimum of 15-minute increments with switch to select "NO LOAD" (switch will not transfer) "LOAD" (switch will transfer) exercise period.
13. Two position selector switch to select either automatic or manual retransfer to normal operation.
14. Pushbutton retransfer to normal, operable only when two position selector switch (Refer to Paragraph 2.1.C.13., above) is in the "MANUAL" position.
15. Time delay transfer to emergency, adjustable from 0 to 5 minutes, factory set at one minute.
16. Retransfer to normal time delay, adjustable from 0 to 30 minutes, factory set at five minutes.
17. An inphase monitor to control transfer and retransfer operations between live sources so that closure on the alternate source will occur only when the two sources are approaching or near synchronism (within 15 electrical degrees maximum) so that inrush currents do not exceed normal starting currents. The monitor shall function over a frequency difference range of up to ± two Hz with a maximum operating transfer time of one-sixth of a second. If the voltage of the load-carrying source drops below 70 percent, the inphase function shall be automatically bypassed. The monitor shall not require interwiring with the generator controls or active control of the governor.
18. Overlapping neutral.

D. Electrical and Mechanical Performance: Comply with UL Standard No. 1008 and NEMA Standard ICS2-447. In addition, performance must meet or exceed the following requirements and, if so requested, be verified by certified laboratory test data:
   1. Temperature Rise: Measurements shall be made after the overload and endurance tests.
   2. Dielectric: Measurements shall be made at 1960 VAC RMS minimum following the withstand current rating test.
   3. Transient Withstand: Control panel shall pass the voltage surge withstand test in accordance with IEEE Standard 472-1974 and the voltage impulse withstand test in accordance with NEMA ICS-1-109.
   4. Withstand: UL listed to withstand the magnitude of fault current available at the switch terminals when coordinated with respective protective devices as shown

on the Drawings at an X/R ratio of 6.6 or less. The main contacts shall not trip open or weld when subjected to fault currents.

E. Product and Manufacturer: Provide the following:
   1. The same manufacturer as the switchgear.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the Work is to be installed and notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which they are mounted.

C. Install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 26 43 00

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install surge protective devices (SPD) as a minimum for all 480 VAC and above switchboards and motor control centers above 1,000 amp rating and where shown on the Drawings.
   2. These Specifications describe the electrical and mechanical requirements for a system of electrical surge protective device filter components integrating both surge suppression and electrical high frequency noise filtering.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Referenced Standards. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI/IEEE (C62.41-1991 and C62.45-2002).
   2. National Electrical Code (NEC) current adoptions.
   3. NFPA (70 NEC, 75 and 78).
   4. UL Standard No. 248-1, 1283 and 1449 Third Edition.
      a. Each system component shall be UL Standard No. 1283, Listed as an Electromagnetic Interference Filter.
      b. Each system component shall be UL Standard No. 1449, Third Edition, listed as a Surge Protective Device.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Electrical and mechanical drawings for each type of unit that shows electrical ratings, dimensions, weights, mounting provisions, connection details and layout diagrams.
   2. Provide complete copy of Warranty; refer to requirement of paragraph 2.2.G of this Specification.
   3. Provide verification that the SPD complies with the required UL Standard No. 1449 VPRs.
   4. Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 6kV/3kAcombination wave tested in accordance with ANSI/IEEE C62.45.
   5. Provide spectrum analysis of each unit based on MIL-STD-220A test

procedures between 50 kHz and 200 kHz verifying the device's noise attenuation exceeds 50 dB at 100 kHz.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information. Provide complete copy of Warranty. Refer to requirements of paragraph 2.2.G of this Specification.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unit Operating Voltage: The operating voltage shall be as shown on the Drawings.

B. Maximum Continuous Operating Voltage (MCOV): The MCOV shall be greater than 115 percent of the nominal system operating voltage.

C. Protection Modes: For a wye configured system, the device must have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a delta configured system, the device must have suppression elements between line to line (L-L) and line to ground (L-G).

D. The maximum UL Standard No. 1449 VPR for the device must not exceed the following:
   1. Line to Neutral: 1200 volts.
   2. Line to Ground: 1200 volts.
   3. Neutral to Ground: 1200 volts.
   4. Line to Line: 2000 volts.

E. Surge Current Capacity: For branch applications, total surge current per phase (based on an 8x20 microsecond waveform) that the device is capable of surviving shall not be less than 250 kA per phase, or 125 kA per mode on L-G, L-N and N-G modes (Wye system); L-L and N-G (Delta system).

F. Let through voltage at the Motor Control Center Stabs: Upon request, the manufacturer must provide suppression test results measured at the motor control center bucket stabs.

2.2 DESIGN

A. Each circuit shall include arrays of fused Metal Oxide Veristors (MOV) to suppress voltage surges.

B. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.

Designs incorporating SPD modules which do not provide a balanced impedance path to each MOV shall not be acceptable.

C. Electrical Noise Filter: Each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 55 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL Standard No. 1283. Products not able to demonstrate noise attenuation of 55 dB @ 100 kHz shall be rejected.

D. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.

E. Safety and Diagnostic Monitoring. Each unit shall be equipped with 200 kAIC internal fuses. Each unit shall provide the following three levels of monitoring:
   1. Continuous monitoring of fusing system.
   2. Internal infrared sensor system for monitoring individual MOVs (including neutral to ground). The system must be capable of identifying open circuit failures not monitored by conventional fusing systems.
   3. Thermal detection circuit shall monitor for overheating in all modes due to thermal runaway.

F. A green/red solid state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light; shall indicate which phase(s) have been damaged. Fault detection will activate a flashing trouble light. Units will not be accepted if they cannot detect open circuit damage, thermal conditions, and over current.

G. Warranty: The manufacturer shall provide a full five year warranty from the Date of Shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and National Electrical Code.

H. Product and Manufacturer: Provide one of the following:
   1. General Electric.
   2. Square "D" Company.
   3. Liebert.
   4. Or equal.

2.3 ACCESSORIES

A. The unit must be equipped with surge event counter and audible alarm.

B. Remote Status Monitor. The SPD device must include Form C dry contacts (one N.O. and one N. C.) for remote annunciation of unit status to Computer Control System. The remote alarm shall change state if any of the three monitoring systems described detect a fault condition.

C. Push-To-Test Feature. Each suppression unit shall incorporate an integral test feature which verifies the operational integrity of the unit’s monitoring system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Suppressors shall be installed inside the motor control center at the manufacturer's factory.
B. To facilitate removal and inspection, the suppressor shall be mounted within a standard motor control center bucket.

C. The suppressor shall be mounted in a standard 12-inch NEMA 1 compartment. Conductor length between the suppressor and the stab shall be less than 5-inches. All units shall be internally fused with 200 kAIC. All status indicators and monitors shall be mounted on the front of the motor control center compartment for easy visibility.

+ + END OF SECTION + +

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SECTION 28 05 01

INTEGRATED SECURITY MANAGEMENT SYSTEM – GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

Contractor shall use Netsian Technologies Group at 600 East Gilbert Drive in Tempe, Arizona (480) 505-6849 – Contact Valerie Lander. No equal.

Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish, install, calibrate, test, start-up, commission and place in satisfactory operation a complete Security System. The Security System shall be as specified in Division 28, Electronic Safety and Security, and as shown on the Drawings. The system includes, but is not limited to the following major equipment:

1. Integrated Security Management System
2. Access Control System (ACS).
3. Network Video Record (NVR)
4. Internet Protocol Camera (IP Camera)
5. Intrusion Detection System (IDS).
6. Local Area Network (LAN) with Network Management System.

The Security System shall be a fully functional security system with access control, intrusion detection, IP Camera, and NVR processes integrated into a common monitoring and control platform capable of being controlled from any workstation on the facilities' LAN and/or any offsite workstation on the enterprise-wide security system WAN. The processes, which the Security System shall monitor, and control are described in the Division 28, Electronic Safety and Security Sections of the Project Specifications.

The ACS vendor shall be an authorized distributor of the Andover Continuum™ product line.

NVR's shall be done "in-house".

A System Integrator that is a trained and certified installer of the Andover Continuum™ and Milestone product lines shall be obtained to provide the following services:

7. System Integrator shall install and configure all Security Systems hardware and software, with the exception of door locks and door hardware. The CONTRACTOR shall be responsible for proper materials, installation, grounding, integration, configuration, testing, and performance calibrations of all new and existing hardware and software components of the Security System, including but not limited to:
    a) Door, window, and hatch locks, hardware, and contact switches.

b) Card access readers and keypads.
c) Glass break and motion detectors.
d) Cameras, lenses, pan/tilt units, housings and lightening protection.
e) IP Camera video and data fiber optic transceivers (transmitters and receivers).
f) NVR data acquisition units, primary server, and backup server.
g) Network switches and media converters.
h) Card reader pedestal configurations.
i) Gate operators, UPS power supply, and controller security system enclosure.
j) ACS site and net controllers, I/O and access control modules, and UPS power supply modules.
k) On-site ACS back-up software.
l) IR lighting fixtures.
m) Back-up power operation for all Security System components.
n) Security equipment panel and enclosure components.

1.2 QUALITY ASSURANCE

General:

1. The System Integrator shall identify those system components, which they are not to install or configure.
2. The System Integrator shall supply its company's Quality Assurance Plan. The plans shall include, but not necessarily be limited to: method of testing, raw material criteria, methods of documentation, station control, "Burn-In", final tests and serialization coding and packaging.

Security System Integrator's Qualifications:

3. Be a financially sound firm having at least five years of continuous experience in designing, implementing, supplying and supporting instrumentation and control systems, which are comparable to the Security System in terms of hardware, software, cost and complexity.
4. Have supported standard lines of digital processing and control equipment and application software continuously for the last five years.
5. Have in existence at the time of bid advertisement, an experienced engineering and technical staff capable of implementing, supplying and supporting the Security System and handling the Security System submittals and training requirements.
6. Have a minimum two years of experience in hardware application and programming of computer control systems and Ethernet based networks.
7. Have a thorough working knowledge of security system processes and control philosophy in accordance with standard practices of the security industry.
8. Have a system of traceability of the manufactured units and purchased components through production, assembly and testing.
9. Have a system of "Burn-In" for all components and available supportive documentation.
10. Have a demonstrated record of prompt response to field failures.
11. Have a documented program of failure analysis.

12. Have a record of prompt shipments in accordance with contract obligations required for previous projects.
13. Shall have a warranty covering parts, spare parts and labor and in the case of microprocessor-based equipment and its appurtenances, a guaranteed availability clause.

Technical Proposal Requirements: The successful, responsive, responsible Bidder shall submit to OWNER a copy of a Technical Proposal from the System Integrator that has selected to provide the Security System. The Technical Proposal shall be submitted fourteen (14) days after the Notice to Proceed. The Technical Proposal shall be complete and contain all information as specified below.

14. Financial Statement: Include the value of security systems delivered during the last two fiscal years. Also, include the value of other security systems currently being installed during the period.
15. Experience:
    a. Provide evidence of compliance with the specific experience requirements listed in Paragraph 1.2.B., above, in the form of an experience certification signed by an officer of the company.
    b. Describe at least three completed municipal projects utilizing security system equipment identical to or similar to (indicate which) that specified. Indicate owner, value, completion date, names and phone numbers of owner's representatives familiar with each project. Letters of recommendation may be submitted.
    c. Furnish list of last ten projects completed.
16. Personnel: Provide a listing of those personnel committed to be assigned to the Project. List shall include Project Manager, Project Engineer, Field Representative, and local service representative. Indicate addresses of personnel not based at Security System Integrator's main office. Provide documentation including resumes of personnel demonstrating experience in Security Systems installation and integration.
17. Exceptions: List all exceptions and deviations from the requirements of the Specifications. Reference Section Number, Article, and Paragraph of proposed variance and provide an explanation of why the proposed substitution meets (or exceeds) the functional or equipment requirements specified.
18. Shipment Records: Provide evidence of timely delivery of equipment on past projects.
19. Integrated Security Management System Hardware:
    a. Provide descriptive literature and catalog information covering the features and capabilities of all proposed hardware components.
    b. Describe standard software packages proposed, including any customized software required to meet the functional intent of the system Specifications.
20. Instrumentation and Panel Mounted Devices: Provide descriptive literature and catalog cuts for each type of sensor, transmitter, indicator, and other such devices required by the project.
21. Training: Provide information and literature as to the organization proposed and the factory facilities to be utilized for the training specified. Indicate the qualifications of the factory training staff.
22. Start-Up and Field Testing: Indicate how the Availability Demonstration will be accomplished.

23. Maintenance: Provide the following information:
    a. Location of service facility along with minimum and maximum response time.
    b. Location of parts facility with delivery time and method.

Operating Experience or Bonding Alternative:

24. The facilities outlined in the Contract Documents, included herein, have been designed to meet stringent quality standards. OWNER and ENGINEER have selected and designed a Security System to provide effective security monitoring and control for the facilities required to meet these stringent quality criteria limitations. The criteria for selection of these systems includes, but is not limited to, the following:
    a. The use of standard, "non-custom" equipment and application software.
    b. The ability of OWNER'S personnel to make modifications and adjustments in the field to react to actual field conditions.
    c. The ability of OWNER to obtain training of OWNER'S personnel in well established equipment manufacturer training programs.
    d. The availability of factory service and a well stocked spare parts inventory, which could be drawn upon by OWNER in emergency situations.
    e. The ability of OWNER to obtain all software drivers and custom software needed to integrate the security system components for use on other OWNER projects at no additional cost for the software and driver development.
    f. The ability of OWNER to obtain all security systems software and driver licenses needed to add additional system components of identical make and model within the water treatment plant campus at no additional cost on future security system upgrade projects.

25. The requirements listed in Paragraph 1.2.B., above, include specific experience requirements. Should a Security System Integrator lack the required five years of experience, it will have the option of posting a performance bond in the amount of 100 percent of the system equipment price. This bond shall cover a period of time that a Security System Integrator is deficient from the five-year experience requirement. For example, if a Security System Integrator has only two years of experience, the Security System Integrator must post along with an experience certification signed by an officer of the company, a bond in the amount of 100 percent of the system equipment price for a period of three years following acceptance of the system by OWNER. The purpose of this bond shall be to indemnify OWNER against all losses incurred by reason of the failure of any system or equipment in any aspect of the quality standards required or intended by these Specifications. OWNER considers losses to include costs incurred to remove a defective system, modify structures as required, purchase and install replacement systems and costs involved with correcting, to OWNER'S satisfaction, all system and equipment deficiencies to the quality standards required and intended by these Specifications. The premium cost of this bond shall be included in the price bid for this equipment. The bond shall be in addition to any other bonds specified in the Contract Documents. All Security System Integrator lacking the total five years operating experience shall submit, as part of the specified Technical Proposal submittal, a

copy of the bond from an acceptable surety along with a letter from the surety stating that it will issue the bond for the full value of the equipment price.

Security System Integrator's Responsibility:

26. Retain the Security System Integrator to undertake the responsibilities specified below. However, execution of these specified duties by the Security System Integrator shall not relieve CONTRACTOR of the ultimate responsibility for the Security System.
    a. Design, fabrication and implementation of the Security System and all subsystems in accordance with the Contract Documents and all referenced standards and codes.
    b. Preparation, assembly and correction of all Security System submittals in accordance with the Contract Documents.
    c. Proper interfacing of ACS hardware, software, field devices and panels, including required interfacing with packaged control systems furnished by other equipment suppliers, and with the plant electrical system.
    d. Supervision of the installation of Security System, devices, panels, consoles, cabinets, wiring and other components required.
    e. Installation, configuration, integration, calibration, testing, start-up and commissioning of the Security System.
    f. Training of OWNER'S personnel in operation and maintenance of the Integrated Security Management System.
    g. Handling of all warranty obligations for the Security System components.

Reference Standards:

27. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in the Contract Documents:
    a. ISA, The Instrumentation, Systems and Automation Society.
    b. API, American Petroleum Institute.
    c. UL, Underwriters' Laboratories, Inc.
    d. AWWA, American Water Works Association.
    e. NRC, Nuclear Regulatory Commission.
    f. NEMA, National Electrical Manufacturers Association.
    g. OSHA, Occupational Safety and Health Administration.
    h. ANSI, American National Standards Institute.
    i. MIL, Military Standards.
    j. NFPA, National Fire Protection Association.
    k. SAMA, Scientific Apparatus Manufacturers Association.
    l. NFPA, National Fire Protection Association 79, Annex "D" Standards.
    m. IEEE, Institute of Electrical and Electronic Engineers.
    n. National Electrical Code (NEC) current adoption.
    o. City of Phoenix – Amendments to the National Electrical Code.
    p. FM, Factory Mutual.
    q. City of Phoenix Water Services Department Security Guidelines and Standards.

1.3 COORDINATION AND PROGRESS MEETINGS

Responsibility for the scheduling and coordinating the system installation with regard to all other Work on the site and in accordance with the provisions of the General Conditions, belong to CONTRACTOR. Said coordination shall be documented on the Project Schedule.

Routine progress and coordination meetings will be scheduled by ENGINEER. CONTRACTOR and a representative of the Security System Integrator shall be required to attend.

The purpose of the meetings shall be to review the progress of the Work involving the Security System and provide coordination for installation of the equipment to ensure that the Project Schedule is met.

Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit CONTRACTOR and Security System Integrator to agreed procedures and schedules.

1.4 SECURITY SYSTEM INTEGRATOR PROJECT PERSONNEL

Require the Security System Integrator to provide the following project personnel:

1. Project Manager:
    a. The Security System Integrator shall appoint a Project Manager who shall coordinate and schedule all Work and assure that the Project Schedule is met.
    b. The Project Manager shall act as the liaison with CONTRACTOR for the installation of the Security System equipment and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.
2. On-Site Project Engineer:
    a. Security System Integrator to appoint a full-time, on-site Project Engineer to remain during the period from the Security System Integrator's installation through Final Completion of the Work.
    b. Project Engineer to ensure Security Systems installation remains on schedule and to communicate to the Project Manager where potential problems may arise.
    c. Project Engineer shall assist the Field Engineer with testing and to ensure existing plant processes are not interrupted during testing.
3. Field Engineer:
    a. The Security System Integrator shall appoint a Field Engineer with respon-sibilities as follows:
        1) Provide advice and technical consultation relative to installation techniques and procedures for equipment furnished.
        2) Installed system checkout, calibration, adjustment, start-up and commissioning.
        3) Maintenance services during availability demonstration.
        4) Involvement in the on-site system training of plant personnel.
        5) Resolving of Security Systems integration, configuration, and calibration problems encountered during initial start-up, testing, and commissioning of all Security System equipment.

6) The Field Engineer shall have a minimum five years of experience in systems engineering and start-up and shall have a thorough working knowledge of both the hardware and software supplied for the Security System.

b. Training Personnel:
   1) Comply with requirements of Section 28 08 13, Integrated Security Management System – Training, and Section 01 79 00, Instruction of Operations and Maintenance Personnel.

1.5 SUBMITTALS

Shop Drawings:

1. General:
   a. Shop Drawing submittals are to be in accordance with the requirements of the Contract Documents.
   b. Shop Drawing preparation shall not commence until after the Pre-Submittal Meeting specified below.
   c. Security System Integrator shall not commence until related submittals have been approved by ENGINEER.
   d. Shop Drawings shall be submitted in complete packages grouped to permit review of related items as generally outlined in Paragraph 1.5.A.3., below.
   e. Review of Shop Drawings will be for conformance with Contract Documents and with regard to functions specified to be provided.
2. Submittal Requirements:
   a. Product information for all Security System components, devices, equipment, and contact closures. Include the following:
      1) Manufacturer's product name and complete model number.
      2) Equipment tag and circuit number from Contract Documents.
      3) Manufacturer's data sheets and catalog literature.
      4) Description of construction features.
      5) Performance and operation data.
      6) Installation and mounting details, instructions and recommendations.
      7) Service requirements.
      8) Dimensions.
      9) List of recommended spare parts.
   b. Enclosures and Cabinets Information:
      1) Layout Drawings, include the following:
         a) Front, rear, and internal panel views to scale.
         b) Dimensional information.
         c) Tag number and functional name of components mounted in and on enclosures or cabinet.
         d) Product information on all panel components.
         e) Nameplate location and legend including text, letter size and colors to be used.
         f) Location of anchoring connections and holes.
         g) Location of external wiring and/or piping connections.
         h) Mounting and installation details.
         i) Calculations for cooling.
      2) Wiring diagrams, include the following:

a) Name of enclosure or cabinet.
b) Wiring sizes and types.
c) Wire Management sizes and types.
d) Terminal strip numbers.
e) Color coding.
f) Functional name and manufacturer's designation for components to which wiring is connected.

3) Electrical schematics in accordance with NFPA 79 Standards.
4) Plan showing equipment layout in each area.

System Operation and Maintenance Manuals:

3. Furnish Operations and Maintenance Manuals for the Security System in accordance with Section 01 78 23, Operations and Maintenance Data, and the supplemental requirements below. Operations and Maintenance Data for the Security Systems shall be submitted to the Water Services Department, Security Management Unit representative.
4. The Operations and Maintenance Manuals shall include the following:
   a. Name, address and telephone number of the Security System Integrator local service representative.
   b. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.
   c. Copy of all approved submittal information and system Shop Drawings as specified herein with corrections made to reflect actual system as tested and delivered to the site for installation. Half-size black line reproductions shall be provided for all Shop Drawings larger than 11 by 17-inches.
   d. Manufacturer's original copies of hardware, software, installation, assembly and operations manuals for Security System components and peripheral devices. Manuals shall include the following information:
      1) General descriptive information covering the basic features of the equipment.
      2) Physical description covering layout and installation requirements and all environmental constraints.
      3) Functional and operational descriptions covering the procedures for start-up, shutdown, and calibration of Security System equipment and explaining how the various functions are performed.
      4) Principles of operation explaining the logic of operation; provide information covering operation to a component level.
      5) Maintenance procedures covering checkout, troubleshooting, and servicing; checkout procedures shall provide the means to verify the satisfactory operation of equipment, troubleshooting procedures shall serve as a guide in determining faulty components and servicing procedure shall cover requirements and recommended time schedule for calibration, cleaning, lubrication and other housekeeping and preventive maintenance procedures.
      6) As-built wiring, schematic and logic diagrams.
      7) Safety considerations relating to operation and maintenance procedures.

Record Drawings and Documentation:

5. CONTRACTOR and Security System Integrator revise all system Shop Drawings, submittals and software documentation to furnish Record Drawings and documentation for the Security System in accordance with Section 01 78 39, Project Record Documents, the requirements of the Contract Documents, and the supplemental requirements below.
6. Five copies of all revised Shop Drawings and documentation shall be submitted to the ENGINEER to replace out-dated drawings and documentation contained in the System Operations and Maintenance Manuals. Half-size black line sets shall be provided for all drawings larger than 11 by 17-inches. Specific instructions for out-dated drawing removal and replacement shall be provided with the Record Drawing submittal.
7. Half-size black line prints of wiring diagrams applicable to each enclosure shall be placed inside a clear plastic envelope and stored in a suitable print pocket or container inside each enclosure. Wiring diagrams shall be provided in AutoCAD .dwg format, version 2017.

Reports:

8. Two copies of the following reports shall be submitted to ENGINEER and OWNER:
   a. Installation Inspection, Field Calibration, and Field Testing Reports as specified in Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

1.6 EQUIPMENT DELIVERY, HANDLING AND STORAGE

Make all arrangements for transportation, delivery and storage of the equipment and materials in accordance with the requirements of the Contract Documents, requirements of the Security System Integrator, and requirements of equipment manufacturers.

Security System equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration or other damages. Clearly label contents of each container and provide information on the required storage conditions necessary for the equipment. Keep OWNER and ENGINEER informed of equipment delivery.

All equipment shall be handled and stored in accordance with manufacturer’s instructions and relevant organization standards. Equipment shall be protected from weather, moisture and other conditions that could cause damage. Items that require a controlled environment for storage such as panels and microprocessor units shall be stored in a climate controlled warehouse or facility. Security System Integrator shall notify CONTRACTOR, in writing, with copies to OWNER and ENGINEER of the storage requirements and recommendations for the equipment prior to shipment.

1.7 GENERAL INTEGRATED SECURITY MANAGEMENT SYSTEM REQUIREMENTS

Power Supplies:

1. All electrically powered equipment and devices shall be suitable for operation on 115-volt, ± 10 percent, 60 Hz ±2 Hz. If a different voltage or closer regulation is required, a suitable regulator or transformer shall be provided.
2. Appropriate power supplies shall be furnished by CONTRACTOR for all Security System devices. Power supplies shall be mounted in enclosures and installed in the appropriate room or field panel.
3. Design all power supplies for a minimum of 130 percent of the maximum simultaneous current draw.
4. Furnish a power on-off switch or an air circuit breaker for each item requiring electrical power.
5. Provide isolation transformers, line voltage regulators and power distribution panels for the distributed digital portions of the Security System to eliminate electrical noise or transients entering on the primary power line.

Signal Requirements:

6. Provide signal converters and repeaters, where required
7. Signals shall be isolated from ground.
8. The system and associated input/output wiring will be used in a plant environment where there can be high energy AC fields, DC control pulses, and varying ground potentials between the security devices or input contact locations and the system components. The system installation shall be adequate to provide proper protection against interferences from all such possible situations.

Miscellaneous:

9. All instrumentation and Security System components shall be heavy-duty types, designed for continuous service in a municipal treatment plant environment. The system shall contain products of a single manufacturer, where possible, and consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and be capable of field expansion through the installation of plug-in circuit cards or modules and additional enclosures as necessary.
10. All Security System components shall be designed to return automatically to operational configuration upon restoration of power after a power failure or when transferred to standby power.
11. Surge protection shall be provided for all Security System components, which could be damaged by electrical surges.
12. All field-mounted Security System components shall be designed for installation in humid and corrosive service conditions. All field mounted instrument enclosures and appurtenances shall conform to stainless NEMA 4X requirements, unless otherwise specified.
13. All relays with interconnections to field devices shall be wired through terminal blocks.
14. All enclosure mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance.
15. All components furnished shall be tagged with the item number and nomenclature indicated on the Contract Documents.
16. Ranges and scales specified herein shall be coordinated to suit equipment actually furnished.
17. Field-mounted devices shall be treated with an anti-fungus spray as manufactured by Humi Seal Corporation, Type 1A331A33, or equal. Purchase

12, 16 oz spray cans to be after the instrument is permanently mounted. The devices requiring the ant-fungus spray will be field directed by the Engineer. All remaining 16 oz cans are to be turned over to the owner.

18. Field-mounted devices shall be protected from exposure to freezing temperatures and shaded from direct sunlight.

Environmental Conditions:

19. The Integrated Security Management System shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
    a. Control Rooms:
        1) Ambient Temperature: 60°F to 80°F normal range; 40°F to 105°F occasional maximum extremes.
        2) Relative Humidity: 80 percent, normal; 95 percent maximum.
    b. Indoor locations for digital processing equipment hardware, control panels and instruments:
        1) Ambient Temperature: 40°F to 120°F.
        2) Relative Humidity: 98 percent maximum.
    c. Outdoor locations for instruments:
        1) Ambient Temperature: -10°F to 131°F.
        2) Relative Humidity: 100 percent maximum.

System Designs:

20. Range, scale and setpoint values specified in other Division 40, Process Interconnections, Sections are for initial setting and configuration. Modifications to these values may be required based on actual equipment furnished and as necessary to implement proper and stable process action and that is determined as systems are placed in operation. These modifications shall be done at no additional cost to OWNER.
21. For any items where ranges, scales and setpoints may not have been specified, submit a recommendation to ENGINEER for review.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 28 05 46

SECURITY SYSTEM CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install instrumentation, telephone cables and security system fiber cables.
   2. The types of cable include the following:
      a. Cat6e Cable
      b. Telecommunications Cable
      c. Security Cable
      d. Security Camera Cable

B. The entire instrumentation cable system is considered as one component and shall be provided by a single source, hereafter referred to as the Supplier. The only exception permitted is telecommunication cable, as defined in this specification, and the provider of telecommunication cable shall be pre-approved by the City of Phoenix Water Services Department (WSD) Network Security Services.

1.2 QUALITY ASSURANCE

A. Refer to Section 28 05 01, Integrated Security Management System – General Requirements.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. TIA/EIA-568-B.1 with Addendums, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
   2. TIA/EIA-568-B.2 with Addendums, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components.
   3. TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
   4. TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure.
   5. J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
   6. City of Phoenix, (WSD) Network Security Services cabling standards.

C. Permits and Inspections:
   1. Material and workmanship shall conform to all applicable legal and code requirements, and as specified in the Contract Documents.
   2. Shall perform all tests required to demonstrate conformance with the Contract Documents.

D. Job Conditions:
   1. Shall ensure that all conduits, junction boxes, outlets, and other openings are kept covered to prevent foreign matter entry.
   2. During installation ensure all materials are kept safe from dirt, water, or other materials that could damage it.
   3. The installation is to be supervised on a regular basis by a person designated by the CONTRACTOR. This person shall be authorized and shall be competent to oversee all aspects of the project.

E. This section does not detract in any way with Quality Assurance Provisions of Division 1.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Proposed instrumentation cables and cable accessories (terminations) identification sequence and labeling.
   2. Manufacturer's technical information for telecommunications cable and underground splicing for approval by the City of Phoenix, (WSD) Network Security Services.
   3. Cut sheets and catalog literature for proposed instrumentation cables and cable accessories (terminations).
   4. Manufacturer specifications and data which clearly and unambiguously shows that the instrumentation cables and cable accessories (terminations) meets all the requirements specified herein.
   5. Samples of the proposed instrumentation cables.
   6. Physical dimension drawings of instrumentation cables and cable accessories (terminations).
   7. Provide a Recommended Spare Parts List (RSPL).
   8. Manufacturer's recommended installation procedures.
   9. Proposed cable test forms.

1.4 SYSTEM ACCEPTANCE

A. Refer to Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

B. All instrumentation cable systems shall be installed and tested in accordance with the manufacturer's warranty requirements, the latest ANSI/TIA/EIA testing procedures.

1.5 WARRANTIES

A. The CAT6a compliant cabling system shall be a complete end to end (channel) Ortronics/Berk-Tek Netclear solution or equal, and warrant that all materials and equipment furnished under the contract are in good working order, free from defects, and in conformance with system specifications. All installed equipment for CAT6a compliant cabling system must conform to the manufacturer's official applications assurance and product warranty information. The CAT6a compliant cabling system warranty shall begin at the system acceptance date and remain in effect for a period

of 25 years from that date. A single Supplier shall be responsible for certifying and warranting all components of the CAT6a compliant cabling system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cat6e Cable
B. Cable for the connection of PTZ cameras:
    a. Cat6e underground rated Cable and Cat6e patch cords UL Listed.

C. Product and Manufacturer: Provide one of the following:
    a. Berk Tek
    b. Commscope
    c. Or equal

D. Telecommunications Cable:
    1. All cables installed for City of Phoenix telephone and enterprise network systems shall be installed per the latest version of the Information Technology Systems Telecommunications Cabling System Standards.
    2. Product and Manufacturer: Provide one of the following:
        a. Berk Tek.
        b. Or equal.

E. Security Cabling:
    1. Cable for the connection of security systems device modules shall be as specified below:
        a. Card Reader Cables: 18 AWG minimum, 6 conductors shielded.
        b. Door Contact Cables: 18 AWG minimum, 2 conductors shielded.
        c. Glass Breakage Sensor Cable: 18 AWG minimum, 4 conductors shielded.
        d. Motion Detector Cables: 18 AWG minimum, 4 conductors shielded.
        e. Electrified Locks Cables: 16 AWG minimum, 2 conductors non shielded.
        f. Infinet Bus Cables: 24 AWG, 1 pair shielded, Low Capacitance 12.5 pF, 100 Ohms.
    2. Product and Manufacturer: Provide one of the following:
        a. Belden.
        b. Mohawk.
        c. Or equal.

F. Security Camera Cable:
    1. Product and Manufacturer: Paige Electric 258330804 Gamechanger. No equal.

G. Cable Markers:
    1. Provide only heat shrinkage type cable identification, which shall be type-written.
    2. Product and Manufacturer: Provide the following:
        a. By W.H. Brady Company. (Part # PSPT-500-1W for a twisted pair shielded cable)
        b. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Separation Requirements:
   1. Coaxial Cables shall not be routed separately from other cables unless noted on drawings.
   2. Telecommunications Cables are to be routed separately from other cables.
   3. Security System Cables are to be routed separately from other cables unless noted on the drawings.

B. Install all cables complete with proper identification and terminations at both ends.

C. Terminate stranded conductors with pre-insulated crimp type spade or barrel compression fitting terminals properly sized to fit fastening device and wire size.

D. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.

E. Coordinate the installation and termination of the Telecommunications cables with the City of Phoenix, (WSD) Network Security Services.

F. Install in conformance with the National Electrical Code and the City of Phoenix Electrical Code.

3.2 FIELD QUALITY ASSURANCE

A. Performance Specification Requirements: Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated.

B. General overall performance of a product is implied where the product is specified for a specific application. All equipment shall be installed per applicable UL listing for that device or component.

C. Comply with manufacturer’s instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

3.3 CABLE DAMAGE DURING INSTALLATION

A. If an instrumentation cable becomes damaged during installation stop operations and notify the ENGINEER immediately. If requested by the ENGINEER test the cable in accordance with the test procedures of this specification. Requiring a test of the damaged cable shall not be a basis of extra payment or extension of Contract completion time. The ENGINEER will decide whether to replace the entire reel of cable or to install a splice at the damaged section.

B. If the ENGINEER requests to have the entire reel of cable, begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the OWNER. Installation of new cable to replace damaged cable shall not be a basis of extra payment or extension of Contract completion time.

C. If the ENGINEER approves installation of a splice at the damaged point, then submit the proposed splicing method to the ENGINEER. Furnish all materials and labor necessary to perform the splice in accordance with the approved requirements. Requiring one or more splices, or additional cable, to replace the damaged portions of the cable shall not be a basis of extra payment or extension of Contract completion time.

D. If the ENGINEER requests installation of a splice at the damaged point, and the cable is damaged (by appearance or as demonstrated by test results) a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels. Installation of new cable to replace damaged cable shall not be a basis of extra payment or extension of Contract completion time.

3.4 TESTING

A. Acceptance testing of instrumentation cables shall be per Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

B. Instrumentation cable shall not be tested without an ENGINEER witness on site to observe the means in which the cable is being tested. All test that occur without an ENGINEER witness shall be retested. Retesting of instrumentation cables shall not be a basis of extra payment or extension of Contract completion time.

C. All instrumentation cable testing shall be documented on pre-approved test forms. Three copies of all test documents and forms shall be submitted to the ENGINEER upon successful completion of the testing.

D. Telecommunications cables shall be tested in accordance with and in the presence of the City of Phoenix, (WSD) Network Security Services. A written proposed schedule shall be submitted a minimum of seven days prior to the testing of each telecommunications cable for inspection coordination.

+ + END OF SECTION + +

SECTION 28 08 13

INTEGRATED SECURITY MANAGEMENT SYSTEM TRAINING

PART 1 - GENERAL

1.1 REQUIREMENTS AND RESPONSIBILITIES

A. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER.

B. Retain the services of the Systems Integrator to provide operation and maintenance training for all Security System equipment as specified herein.

C. Responsibility for all costs associated with, including all required materials, texts and required supplies, belongs to CONTRACTOR.

D. All training shall be conducted in the normal eight hour working days until conclusion of the training course.

1.2 SUBMITTALS

A. Submit his plan for training conforming to the requirements of Section 01 79 00, Instruction of Operations and Maintenance Personnel. Included in the plan shall be course outlines and schedules for training.

1.3 ON-SITE TRAINING

A. Integrated Security Management System:
   1. Provide on-site operation and maintenance training by Systems Integrator prior to placing the equipment in continuous operation, conforming to the requirements of Section 01 79 00, Instruction of Operations and Maintenance Personnel and shall include the following sub-systems:
      a. Access Control System (ACS)
      b. Network Video Management System (NVMS)
      c. IP Camera System
      d. Intrusion Detection System (IDS)
   2. Training shall accomplish the following:
      a. Provide instruction covering use and operation of the equipment to perform the intended functions.
      b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance for the following sub-systems:
      c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall Integrated Security Management System.

B. The minimum training hours shall comply with Section 01 79 00, Instruction of Operations and Maintenance Personnel and be provided for all scheduled work shifts as required.

PART 2 - PRODUCTS (NOT USED)

2.1 EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 28 14 19

INTEGRATED SECURITY MANAGEMENT SYSTEM - ENCLOSURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contract Documents illustrate and specify functional and general construction requirements of the enclosure components and do not necessarily show or specify all components, wiring, and accessories required for a completely integrated system.
   2. Provide all labor, materials, equipment, documentation including drawings and incidentals as shown on the drawings, specified and required to design, furnish, install, calibrate, test, start-up, program, configure, commission and place into satisfactory operation all enclosures including enclosure components and instruments.
   3. Conform the design and construction of enclosures to the specifications herein.

B. Coordination:

   1. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 DEFINITIONS

A. Security Power Supply Enclosure: A Security Power Supply Enclosure is an industrial rated enclosure that contains a power supply and/or networking modules for Internet Protocol (IP) Cameras, Intrusion Detection Systems, Access Control Systems, and door hardware. A security power supply enclosure contains voltages of 120VAC or below.

B. Security System Enclosure (SSE): A Security System Enclosure is an industrial rated enclosure that contains security controllers and modules, in addition to wire terminals. Typically, it is a local enclosure connected to security devices (i.e. card readers, door contacts, motion detectors, and glass breaks to provide control and/or monitoring of these devices. A security system enclosure contains voltages of 120VAC or below.

1.3 QUALITY ASSURANCE

A. Reference Standards: Construction of enclosures and the installation and interconnection of all equipment and devices mounted within also comply with applicable provisions of the following, except where otherwise shown or specified.
   1. National Fire Protection Association 79
   2. National Electrical Code (NEC) current adoption.
   3. City of Phoenix – Amendments to the National Electrical Code.
   4. National Electrical Manufacturer's Association Standards (NEMA)
   5. American Society for Testing and Materials (ASTM)
   6. Operational Safety and Health Administration (OSHA) Regulations
   7. State and local code requirements
   8. Where any conflict arises between codes or standards, the more stringent requirement applies.
   9. All enclosure devices shall bear the label of the Underwriters' Laboratory (UL), Inc. The UL listed number shall be documented on the Bill of Materials on the drawings.
   10. The assembled enclosures are to be conformed to meet UL 508 requirements and labeling.

1.4 SUBMITTALS

A. General:
   1. Reference Section 01 33 00 Submittal Procedure.
   2. Enclosures shall be furnished in accordance with the requirements as shown on the Drawings, and as specified in Division 28.
   3. Generate drawing package utilizing AutoCAD 2017 or newer.
   4. Submit legible hard copies of the enclosure drawing package printed on 11" x 17" sheets.
   5. Submit an electronic copy of the enclosure drawing package on a CD.
   6. Submit manufacturer's technical data sheets and product literature for the enclosures and all components utilized. Cleary identify exact equipment and material that is being supplied on the manufacturer's data sheets.
   7. Submit a sample nameplate with the submittal.
   8. Identify general location of all conduit entry points on the Front Elevation drawing of the documentation package.
   9. Submit calculations and recommended Air Conditioning Unit for cooling and heating load requirements. Utilize the Hoffman Temperature Calculation tool at: http://www.hoffmanonline.com
   10. Submit location and tube routing details for air conditioner drain line. Coordinate drain location with ENGINEER.

1.5 O&M MANUALS

A. Comply with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. Provide drawings of the enclosure upon delivery of the enclosure.

PART 2 - PRODUCTS

2.1 ENCLOSURES

A. General:
   1. Conform enclosures to the NEMA requirements for the type specified.
   2. Sizes shown on contract drawings are estimates. Furnish enclosures sized to house all equipment, instruments, front enclosure mounted devices, power supplies, power distribution enclosures, wiring and other components installed within.
   3. Size the enclosure to provide ten (10) percent spare capacity.
   4. Floor Pad: Refer to Part 3.4 of this Section.
   5. Use stainless steel fasteners throughout.
   6. Provide interior mounting enclosures and shelves constructed of minimum 12 gage steel.
   7. Provide steel print pocket with white enamel finish.
   8. Provide enclosure mounting supports as required for floor, frame, or wall mounting. Indoor wall mount enclosures utilizing stainless steel unistrut. Outdoor wall mount enclosures utilizing PVC coated unistrut.

B. Construction Features:
   1. General Construction Features:
      a. Provide the following convenience accessories inside of each enclosure.
      b. One or more 120 VAC fluorescent light fixtures with a 40 watt lamp powered by a separate 20A lighting enclosure circuit with an isolating circuit breaker and a snap switch for on/off control.
      c. One centrally mounted 120 VAC, 20A GFCI type receptacle powered by the enclosure lighting circuit. Provide a convenience receptacle for each cubicle of Enclosures over four feet.
      d. Provide grounding studs or lugs for metal Enclosures and doors.
      e. Provide all electrical components and devices, support hardware, fasteners, and interconnecting wiring required to make the enclosures complete and operational.
      f. Provide oil resistant gasket completely around each door or opening.
      g. For enclosures located in the field or outdoors that have door mounted devices which do not meet the NEMA rating for the area, provide a window kit that includes a hinged door with a clear plastic window and an oil

resistant gasket to encompass all non-NEMA rated enclosure instruments for this area.

h. Provide full height doors.

i. Provide Enclosures with no extra holes or knockouts unless shown on Contract drawings.

2. NEMA 12 Enclosures:

a. Fabricate enclosures using minimum 14 gage steel for wall or frame mounted enclosures and minimum 12 gage for free standing enclosures. Keep steel free of pitting and surface blemishes.

b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.

c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.

d. Provide enclosures with flatness within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Verify flatness by using a 72-inch long straight edge. Limit out-of-flatness to gradual and in one direction only with no obvious depressions or wavy sections.

e. Use pan type construction for doors. Door widths are not to exceed 36-inches.

f. Mount doors with full length heavy duty piano hinge with stainless steel hinge pins.

g. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.

h. Product and Manufacturer: Provide one of the following:
   1) Hoffman
   2) Hammond
   3) Or Pre-Approved Equal

i. Painting:
   1) Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Apply zinc phosphate for corrosion protection.
   2) Apply one coat of primer interior and exterior surfaces immediately after corrosion protection has been applied.
   3) Coat exterior surfaces with primer surface applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
   4) Paint all exterior surfaces minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.

5) Provide compatible primer and finish paint with a low VOC, high solids polyurethane enamel. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.
6) Product and Manufacturer:
   a) Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin Williams, Inc
   b) Pre-Approved Equal.

3. NEMA 4X Enclosures:
   a. Provide enclosures with Type 316 stainless steel construction. Fabricate enclosures using minimum 14 gage steel for wall or frame mounted enclosures and minimum 12 gage steel (except those areas requiring reinforcement) for free standing enclosures. Keep steel free of pitting and surface blemishes. Provide all surfaces with a smooth brushed finish.
   b. Provide stainless steel fast-operating clamp assemblies on three sides of each door.
   c. Rolled lip around three sides of door and along top of enclosure opening.
   d. Provide a hasp and staple for padlocking.
   e. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the enclosure to its floor pad for free-standing enclosure.
   f. Provide 5/16-inch diameter copper ground studs for the ground connection points for all enclosure equipment and enclosure doors.
   g. Product and Manufacturer: Provide one of the following:
      1) Hoffman
      2) Hammond
      3) Or Pre-Approved Equal

4. NEMA 7 Enclosures;
   a. General:
      1) House monitoring and measuring devices located in hazardous environments in explosion-proof enclosures.
   b. Enclosures rated for use in NEC Class 1, Groups C&D or Class II, Groups E, F & G applications and comply with UL and CSA standards.
   c. Required Features:
      1) Light weight and corrosion resistant copper-free aluminum
      2) Integral, cast-on mounting lugs
      3) Left side door hinges
      4) Viewing windows sized to suit internally mounted components
      5) Stainless steel cover bolts
      6) Cad-plated steel mounting pans
   d. Product and Manufacturer: Provide one of the following:
      1) Adalet
      2) Killark
      3) Crouse-Hinds

4) Or Pre-Approved Equal

C. Environment
1. General:
a. Provide a separate lighting enclosure circuit for air conditioners, heat exchangers, ventilation fans or heaters.
b. Provide calculations for cooling and heating load requirements.
c. Provide thermostats to automatically control heating, cooling, ventilation requirements.
2. Air Conditioners:
a. Coordinate utilization of air conditioners with the ENGINEER.
b. Provide an automatically controlled closed loop air conditioner with filtered and adjustable air louvers to maintain temperature inside each enclosure below the maximum operating temperature rating of the lowest rated component.
c. Provide a condensation drain line for each air conditioner.
d. Coordinate space requirements for maintenance.
e. Provide NEMA 4X for outdoor locations.
f. Coat heating and cooling elements including external housing that are in contact with Plant's ambient environment with Heresite, or equal, for protection from hydrogen sulfide corrosion with hydrogen sulfide levels up to seven ppm.
1) Coordinate application of coating with the ENGINEER.
g. Product and Manufacturer:
1) Hoffman (McClean)
2) Or Pre-Approved Equal
3. Heat Exchangers:
a. Coordinate utilization of heat exchangers with the ENGINEER.
b. Provide an automatically controlled heat exchanger to maintain temperature inside each enclosure below the maximum operating temperature rating of the lowest rated component.
c. Coordinate space requirements for maintenance.
d. Products and Manufacturers:
1) Hoffman
2) Or Pre-Approved Equal
4. Ventilation Fans:
a. Coordinate utilization of ventilation fans with the ENGINEER.
b. Provide automatically controlled ventilation fans with filter to maintain temperature of indoor/outdoor enclosures below the maximum operating temperature of the lowest rated component.
c. Products and Manufacturers:
1) Hoffman
2) Or Pre-Approved Equal
5. Heaters:

a. Provide adequately sized automatically controlled 120 VAC heaters to maintain temperature inside each enclosure above 40°F to a maximum of 80°F when the outside temperature is 0°F through 40°F.
b. Product and Manufacturer:
   1) Hoffman
   2) Or Pre-Approved Equal

D. Identification:
   1. Provide laminated plastic nameplates with a white background and black lettering for identification of enclosures and components.
   2. Construct nameplates with 1/16" plastic and with beveled edges.
   3. Indoor enclosures: mount nameplates to the enclosure utilizing two- part non-sag epoxy as manufactured by Hardman.
   4. Outdoor enclosures: mount nameplates to the enclosure utilizing two-part non-sag epoxy as manufactured by Hardman and with two self-sealing ¼" stainless steel screws by APM Hexseal.
   5. Provide nameplates according to Table 2.1.D.5 and Section 3.1.B:

Nameplate Specifications			
Type	Size	Font	Font Size
Enclosure Nameplate	*2" x 7"	Arial	1/2"
Device Nameplate	*1½"x 2½"	Arial	3/16"
Manufacturer Nameplate	*2" x 4"	Arial	3/16"

Table 2.1.D.5 Nameplate Specifications

*** - This is a minimum size requirement. Size nameplates large enough to display the information required to clearly identify the enclosure.**

2.2 ENCLOSURE DEVICES:

A. General:
   1. Provide DIN rail mounted devices where practical.
B. Internal Component Labeling:
   1. Provide a device label for devices mounted inside the enclosure that conforms to the criteria below:
      a. Instruments: Provide instrument loop number as shown on the P&ID. Place label below the instrument or most visible area.

b. Circuit Breaker: Label each circuit breaker with CB and the number assigned in the circuit breaker schedule. Place label below the instrument or most visible area.
c. Fuses: Label each fuse with FU and the number assigned in the fuse schedule. Place label below the instrument or most visible area.
d. Control Relays: Label each relay with CR and the number assigned in the enclosure drawings. Place label below the relay.
e. Terminal Strips: Label each terminal strip with the terminal strip type. (ex. TB1, TB2, ATB). Place label above the terminal block or at first terminal.
f. Door Mounted Devices: Provide a label on the interior of the front enclosure door for every enclosure device. The label should contain the same information as shown on the front enclosure nameplate. Place the label below the device.

C. Circuit Breakers:
1. Provide single pole circuit breakers with the following features, 120 Volt and 240 Volt AC, DIN rail mounted and UL listed.
2. Provide end caps, marking strips, insulated side jumpers and other accessories.
3. Product and Manufacturer: Provide one of the following models where “xx” is the appropriate rating.
a. Phoenix Contact, TMC 1-M1-xxA
b. Allen-Bradley, 1492-SP1Bxxx
c. Idec, NRC-11-0-L-xxA-AA
d. Or Pre-Approved Equal

D. DC Surge Protection Device:
1. General:
a. Provide maintenance free, self-restoring surge protection to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. Device shall be removable without interrupting the circuit.
2. Required Features:
a. Amp Rating: Compatible with working voltage and current of device being protected.
b. Voltage Rating: Compatible with working voltage of protected device.
c. Reaction Time: nanosecond range.
3. Product and Manufacturer: Provide one of the following:
a. Phoenix Contact, Model
b. Advanced Protection Technologies, Model
c. Comm-Omni International, Model
d. Or Pre-Approved Equal

E. Selector Switches, Pushbuttons and Indicating Lights:
1. General:

a. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
b. Type: Heavy duty, oil tight
c. Mounting: Flush mounted on enclosure front, unless otherwise noted.
d. NEMA rated to match enclosure in which mounted.

2. Selector Switches:
   a. Type: Provide selector switches with number of positions as required to perform intended functions as shown on the Drawings and specified.
   b. Contacts:
      1) Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
      2) Type: Double break, silver contacts with movable contact blade providing scrubbing action.
      3) Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than ten amperes resistive at 120 volts AC or DC continuous.
   c. Switch Operator: Standard black knob.
3. Pushbuttons (Standard or Illuminated):
   a. Momentary Type: Provide momentary, booted type pushbuttons as required to perform intended functions specified and shown on the Drawings. Boot color to be red for stop buttons and black for other functions.
   b. Maintained Type: Provide maintained, push/pull, “Mushroom” type, red in color, to perform intended functions as specified, and as shown on the drawings.
   c. Contacts: Comply with the requirements specified for selector switches.
4. Indicating Lights:
   a. Type: Compact, integral non-transformer type.
   b. Lamps: 120 VAC, long life (20,000 hours minimum).
   c. Common, push-to-test circuitry shall be provided for each enclosure to simultaneously test all indicating lights on the enclosure using a single pushbutton.
   d. Button and Lens Colors:
      1) Red for indication of open, on, or running.
      2) Green for indication of closed, off (ready), or stopped.
      3) Amber for indication of equipment malfunction, process trouble or alarms.
      4) White for indication of electrical control power on.
5. Rotary Cam Switches:
   a. Provide rotary cam switches with number of positions and poles as required to perform the required signal switching function specified and shown on the Drawings.
   b. Contacts:

1) Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required to perform intended functions.
2) Contact Rating: Compatible with AC or DC through-put current of signals and devices simultaneously operated by the switch contacts, but not less than 20 amperes at 600 VAC or 250 VDC continuous.

c. Switch Operator: Standard black knob.

6. Product and Manufacturer: Provide one of the following:
   a. Square D.
   b. General Electric.
   c. Allen-Bradley Co.
   d. Or Pre-Approved Equal

F. Wire:
1. General
   a. Provide internal wiring of Type MTW stranded copper wire with thermo-plastic insulation with no nylon jacket rated for 600 V at 90°C for single conductors.
   b. No utilization of Type THHN for enclosure wiring.
   c. For DC enclosure signal wiring, use #16 AWG shielded minimum.
   d. For AC power wiring, use #14 AWG minimum. For AC signal and control wiring, use #16 AWG minimum. For wiring carrying more than 15 amps, use sizes required by NEC and NFPA 79 Standards.
   e. Identify wires at each end using heat shrink labels with permanent number codes using a Brady LS2000 Labeling System, or equal.
   f. Enclosures conform to the wire color code as shown in Table 2.2.F.1.f Wire Color Code.

WIRE COLOR CODE TABLE (Inside Enclosures)		
TYPE	FUNCTION	INSULATION COLOR
AC POWER (HOT)	120VAC	BLACK
AC POWER (NEUTRAL)	120VAC	WHITE
AC GROUND	120VAC	GREEN
AC CONTROL	120VAC	RED
ISOLATED DC GROUND	GROUND	GREEN W/YELLOW
DC POWER	SOURCE	BLUE
DC POWER	COMMON	WHITE /BLUE
CONTROL	FOREIGN VOLTAGES	ORANGE
LOW VOLTAGE AC	24VAC SOURCE	BROWN
LOW VOLTAGE AC	24VAC COMMON	BROWN W/WHITE
SIGNAL (TWSH PAIR)	ANALOG	RED (POSITIVE) BLACK (NEGATIVE)

Table 2.2.F.1.f Wire Color Code

2. Product and Manufacturer: Provide one of the following:
   a. Carol
   b. Belden
   c. Anixter
   d. Or Pre-Approved Equal

G. Wire Terminations:
   1. Terminate all field and internal component wiring using insulated compression type ferruled lugs attached with manufacturer's recommended tool.
   2. Excessive stripping of the wire to allow bare wire outside the insulated ferrule is not permitted.
   3. Utilize double ferruled connectors wherever two wires terminate on the same terminal block connection.
   4. Product and Manufacturer: Provide one of the following:
      a. Phoenix Contact
      b. Thomas & Betts

c. Weidmuller
d. Or Pre-Approved Equal

H. Terminal Blocks:
1. General
a. Numerically code terminals utilizing terminal block manufacturer's marking system. Information must be printed directly on the terminal label. Sticky back labels are not permitted.
b. Terminal blocks must be din rail mountable with screw clamp connections. Spring cage connections are not permitted.
c. Double level terminal blocks are permitted for use with signals on ATB only.
d. Terminals used for analog signals on ATB shall be colored blue.
e. Terminal block jumpers must be connected via screw clamp. Screw clamped comb jumpers are permitted. Plug in jumpers are not permitted.
2. Product and Manufacturer: For each terminal strip type provide one of the following:
a. Power Terminal Block (PTB)
1) Phoenix Contact, Type UK 5 N, Color Gray, Model # 30 04 36 2
2) Allen Bradley, Type 1492-J4, Color Gray, Model # 1492-J4
3) Weidmuller, Type WSU 4, Color Dark Beige, Model # 1020100000
b. TB1 and TB2
1) Phoenix Contact, Type UDK 3, Double Connection, Color Gray, Model # 27 75 37 5
2) Weidmuller, Type WDK 2.5V, Double Connection, Double Level, Internal Connection, Color Dark Beige, Model # 1022300000
c. ATB - Single Level
1) Phoenix Contact, Type UK 3N BU, Color Blue, Model # 30 01 51 4
2) Allen Bradley, Type 1492-J3-B, Color Blue, Model # 1492-J3-B
3) Weidmuller, Type WDU 2.5 BL, Color Blue, Model # 1020080000
d. ATB-Double Level. Alternating double and single level ATB terminal blocks are permitted.
1) Phoenix Contact, Type MBKKB 2,5 BU, Double Level, Color Blue, Model # 27 71 09 4
2) Allen Bradley, Type 1492-JD3-B, Double Level, Color Blue, Model # 1492-JD3-B
3) Weidmuller, Type WDK 2.5 BL, Double Level, Color Blue, Model # 1021580000
e. Or Pre-Approved Equal

I. Wireways:
1. General:
a. Mount wireways using stainless steel bolts. Drill and tap the sub-enclosure to accommodate the bolts.

b. Color to be Gray or White throughout the entire enclosure. Provide only one color.
c. All wireways to include cover.

2. Product and Manufacturer: Provide one of the following:
   a. Panduit
   b. Thomas & Betts
   c. Or Approved Equal

PART 3 - EXECUTION:

3.1 EXTERIOR ENCLOSURES:

A. Component Layout:
   1. Arrange associated devices and modules for a specific part of the system in close proximity to each other.
   2. Mount indicating lights above control switches and push buttons.
   3. Standard component spacing is 3-1/2 inches on the sides and 3-1/2 inches above and below. It is acceptable to use more space if required, but spatial consistency must be maintained.
   4. Maximum height for enclosures exterior-mounted devices is 6'-0" from the floor. Minimum height for enclosures exterior-mounted devices is 3'-0" from the floor.
   5. Locate horns and annunciators at the top of the enclosure. Horns and annunciators may be located above 6'-0" device height limitation.
   6. Unless otherwise noted; route field wiring through the bottom of the enclosure. Provide watertight conduit openings.

B. Exterior Enclosure Nameplates
   1. General
      a. Refer to Section 2.1.D for material requirements.
      b. Provide specific enclosure identification on nameplates derived from the contract specifications and drawings.
      c. Obtain ENGINEER approval for enclosure identification for enclosures that are not identified in the contract specifications and drawings.
   2. Enclosure Manufacturer Identifier and Power Requirements Nameplate (NP-1)
      a. Mount nameplate in the upper left corner of the enclosure.
      b. Nameplate size to be 2" x 4".
      c. Font to be Arial and letter size to be 3/16 inch
      d. Provide the following information:
         1) The first line indicates the name of the manufacturer who assembled the enclosure and electrical components.
         2) The second line identifies the voltage rating and ampere rating of the enclosure circuitry.
         3) The third line identifies the power phase.
         4) The fourth line is to include the enclosure power feed source, including power enclosure name and circuit number.
   3. Security System Enclosures Identification Nameplate (NP-2)

a. Mount enclosure identification nameplate in the top, center of the enclosure.
b. Nameplate size to be 2” x 7”.
c. Font to be Arial and letter size to be 3/4 inch.
d. Provide the following information:
    1) The first line of text is an abbreviation of the enclosure as shown on the CONTRACT DRAWINGS.
        a) Refer to figure 3.1.B.3a

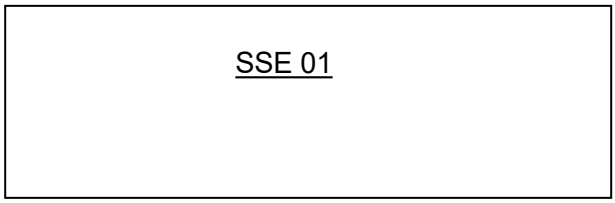

Figure 3.1.B.3a Enclosure Nameplate

4. Security Power Supply Enclosure Nameplates
    a. Mount enclosure identification nameplate in the top, center of the enclosure.
    b. Nameplate size to be 2” x 7”.
    c. Font to be Arial and letter size to be 1/2 inch.
    d. Provide the following information:
        1) The first line indicates the device identifier and number as shown on the DRAWINGS.
        2) The second line identifies the system equipment that the component is associated with.
            a) Refer to figure 3.1.B.4a

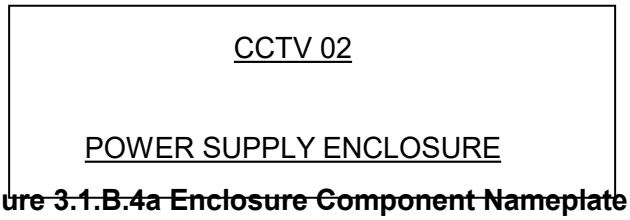

Figure 3.1.B.4a Enclosure Component Nameplate

3.2 INTERIOR ENCLOSURES

A. General:
    1. All Wall Mounted Enclosures - Where conduit enters the enclosure, maintain a minimum of 4-inch clearance from any device or wireway to allow room for routing of field wiring.
    2. Concrete Pad or Floor Mounted SSE’s – Where conduits enter the enclosure through the concrete pad, maintain a minimum of 12-inch clearance from any device or wireway to allow room for routing of field wiring. Where conduit

enters the enclosure sides or top, maintain a minimum of 4-inch clearance from any device or wireway to allow room for routing of field wiring.

3. Elevated Floor Mounted SSE's - Where conduit enters the enclosure, maintain a minimum of 4-inch clearance from any device or wireway to allow room for routing of field wiring.
4. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
5. Maintain a minimum 2'0" clearance between components mounted on side enclosures and components mounted on the opposing side enclosure.
6. Components mounted on the back enclosure are to be unobstructed by any components mounted on side enclosures.
7. Adequately support and restrain all devices and components mounted on or within the enclosure to prevent any movement.
8. Reserve a 10% space on the back or side enclosure(s) for future use.

B. Enclosures Incoming Power:
   1. Enclosure power fed from lighting enclosures or other sources with fused or circuit breaker protection shall be wired to the Power Terminal Blocks (PTBs). Power sources entering the enclosures are to be provided with a separate neutral and ground. The PTBs shall have a separate terminal for the hot, neutral and ground for each circuit.
   2. Mount the PTBs near the top left corner of the enclosure.
   3. Multiple power sources may be required for each enclosure. Power requirements are identified on the CONTRACT DRAWINGS. The following additional power sources may be required for the enclosure.
      a. Security Device Power
      b. Light and Receptacle
      c. Air Conditioning
   4. Arrange the terminal strip in an orderly manner with circuit conductors grouped together. For instance, terminate the hot and neutral conductors on consecutive terminals. Label terminals and internal wiring as H1 and N1 (Control Logic), H2 and N2 (Light and Receptacle), H3 and N3 (Air Conditioning). Identify each additional source in sequential order beginning with H4 and N4.
   5. Terminate all incoming power on one side of the terminal strip.

C. AC Power Distribution:
   1. Identify the wire extending from the PTB to the circuit breakers as H1, H2, and H3 etc. Using H1 as an example; the wire terminated to the line side of the circuit breaker is labeled H1, the wire terminated to the load side of the circuit breaker is labeled as L1-1.
   2. If L1-1 passes through an additional circuit breaker to feed enclosure components, this circuit breaker is to be shown on the drawings in a horizontal position on a schematic rung and the wire terminated to the line side of the

circuit breaker is labeled L1-1, the wire terminated to the load side of the circuit breaker is labeled as the rung number on which it is located.

3. A power source that is used in multiple control circuits requires a circuit breaker for each circuit. For instance, if H1 is applied to multiple circuit breakers, the wire on the line side of the 1st breaker is labeled H1and the wire terminated to the load side of the circuit breaker is labeled L1-1, the wire on the line side of the 2nd breaker is labeled H1and the wire terminated to the load side of the circuit breaker is labeled L1-2 and the wire on the line side of the 3rd breaker is labeled H1 and the wire terminated to the load side of the circuit breaker is labeled L1-3.
4. Powering 120VAC field 4-wire instruments from the enclosure is not permitted.

D. DC Power Distribution:
   1. Mount DC power supplies near the top right of the enclosure. Mount fuses associated with the power supply in close proximity to the power supplies.
   2. Identify terminals used for DC power distribution as PTB-DC.

E. Grounding:
   1. AC Ground:
      a. Provide an AC ground bus bar manufactured of a single copper bar installed near the bottom of the back enclosure with extended mounting bolts.
      b. Provide adequate metal to metal contact between the AC ground bus bar and the back plane.
      c. Connect all AC power sources and devices to ground at this ground bus.
      d. Connect all enclosure enclosure doors to the AC ground bus.
      e. Connect all side enclosures to the AC ground bus.
      f. Provide a connection point on the ground bus for connection to the ground grid system.
   2. DC Ground:
      a. Install an isolated DC grounding bus bar near the bottom of the back enclosure at a minimum distance of 6” from the AC ground bus.
      b. The isolated grounding bus bar consists of two non-conductive mounting blocks with a single copper grounding bar attached between them.
      c. Connect all shields (SH) from analog terminals to the DC grounding bus bar.
      d. To avoid ground loops, connect analog cable signal shields to ground at one location only, preferably in the enclosure; not in the field. Maintain consistency for the termination point of signal shield for all analog signals.
      e. Provide a connection point on the ground bus for connection to the ground grid system.
      f. Figure 3.2.F illustrates a typical ground system within a enclosure. The illustration depicts the physical terminations of the ground wires in the enclosure.

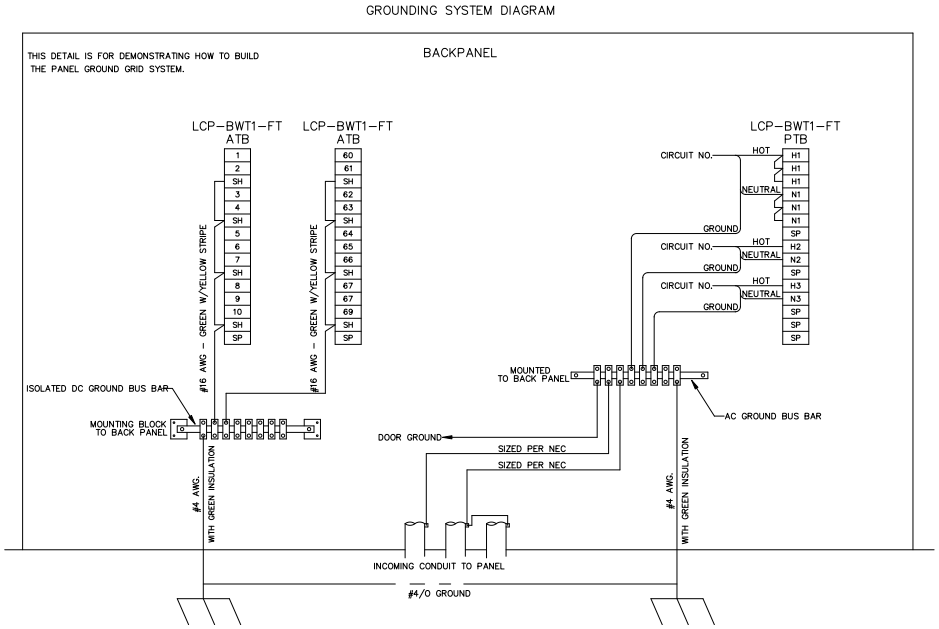

Figure 3.2.F - Enclosure Ground

F. Circuit Protection:
   1. Provide an isolating circuit breaker for each group of control logic. For example: the start, stop and reset control circuit for Pump #1 has a dedicated circuit breaker supplying power to the control logic. Pump #2 requires a separate isolating circuit breaker for the control logic.
   2. Provide an isolating circuit breaker for each component requiring 120VAC power.
   3. A circuit breaker is not required for control circuits powered from a fused control power transformer in an enclosure.
   4. Size circuit breakers to handle the connected load.
   5. Mount circuit breakers next to the PTBs near the top left corner of the enclosure.
   6. Provide a power failure relay with an auxiliary contact for each circuit breaker. Wire each contact in series to send one loss of power signal to the Computer Control System.

G. Internal Enclosure Wiring:
   1. Route all internal wiring using wireways. Route all DC power and analog signals at a minimum of six inches from AC power and controls. When the six-inch minimum distance is not available, provide a metallic barrier that extends 3 inches beyond the tallest wireway between the analog and discrete wireways.
   2. Where wires pass through enclosure walls, provide suitable bushings to prevent cutting or abrading of insulation.

3. Adequately support and restrain all wiring runs to prevent sagging or other movement. Wires extended from the control logic to the enclosure door devices are to be wrapped in plastic protective wire wrap designed for this purpose.
4. Wire splicing is not allowed at any time.
5. Utilize two wires (hot and return leg) with field wiring for each field input. It is not acceptable to utilize one common Hot for multiple field inputs.
6. Terminate wires with a non-insulated ferrule type crimp connector. Excessive stripping of the insulation to allow bare wire strands between the insulation and the ferrule is not permitted.
7. Orientate wire labels on the individual conductor or cable so that wire labels are legible without having to twist or move the connectors. Securely heat shrink the labels around the conductor. Label wires or cables with the number assigned in the enclosure documentation. Refer to Section 2.2.F.1.e for wire label materials.
8. DC wiring for analog and discrete field or Computer Control System signals that enter or leave the enclosure are to be terminated on the Analog Terminal Block (ATB).
9. AC wiring for discrete field signals that enter or leave the enclosure are to be terminated on the Terminal Block 1 (TB1).
10. AC wiring for discrete Computer Control System signals that enter or leave the enclosure are to be terminated on Terminal Block 2 (TB2).
11. The terminal blocks (TB1, TB2 or ATB) can be mounted on the left or right side enclosures.
12. Provide a minimum of 10% spare terminal din rail space per terminal strip.
13. Signals from the field that enter the enclosure and only pass through the enclosure from the field to the Computer Control System require internal wiring from TB1 to TB2.
14. Arrange all control wiring associated with a specific piece of process equipment together on adjacent terminal blocks.
15. Identify wire number by the schematic rung numbers. Label TB1 and TB2 terminals with the rung number associated with the internal wire number connected to the terminal. Label ATB terminals in sequential order starting with the number 1. Identify analog shield terminations with an “SH” on the terminal block.
16. Provide DC surge protection for all analog signal loops. Mount the surge protectors on the ATB. Connect surge protectors so that power is not interrupted in the event of failure or replacement. Effectively ground the surge protectors to the enclosure DC ground bus. Label the surge protectors in sequential order starting with the ATB signals.
17. Multi-conductor cables of two pair or more shall have the outer cable insulation removed before entering the wireway.

H. Wireways:

1. Mount wireways from the internal enclosure components and terminal blocks with a minimum 2-inch spacing.
2. Arrange wireways to maintain a six-inch minimum distance between analog and discrete circuit wiring.
3. Provide wireways for all field wiring. Arrange wireways to allow field wiring to enter from the top or bottom of the enclosure.
4. Align wireways between back and side enclosures.
5. Install a wireway on both sides of each terminal strip.
6. Size wireways to prevent conductor fill from exceeding 50% of the interior cross-sectional area of the wireway.

I. Control Logic:
1. The Start commands are to be designed utilizing normally open contacts from pushbuttons and/or the Computer Control System and shall be of a momentary signal that will require a seal circuit to maintain operation. Constant signals from positions switches are not allowed unless noted on the DRAWINGS.
2. All system failure, safety logic control devices or normal operations that are intended to cause the equipment to stop are to be wired in series with the start seal circuit. The unsealing of the start command on any fault or normal operation that causes the equipment to stop will require another start command to reseal.
3. Provide interlocks for the control functions of Local and Computer Modes in series with the Start and Stop logic. Provide a closed switch or relay contact to the Computer Control System to identify when the equipment is in Computer Mode.
4. Provide control logic of voltage 24 VDC.
5. Use power relays when control relay contacts are insufficient for the designated load.
6. Terminate the “Hot” conductor on the common of the switch or relay contact.

3.3 ENCLOSURE DRAWING DOCUMENTATION

A. General:
1. Develop enclosure drawings using AutoCAD 2017 or newer. AutoCAD files of the title block, enclosure symbols for front and internal sub-enclosure elevations, terminal strips, control schematics, analog loops, etc. are available in hard copy and electronic format from the OWNER upon request through the ENGINEER via Example Enclosure Drawing Packages and Drawing Templates.
2. Provide drawing copies in the following format:
   a. Hard Copy - B Size - 11” X 17”
   b. Hard Copy - D Size - 22” X 34”
   c. Soft Copy in .DWG

3.4 INSTALLATION

A. Install equipment in conformance with NEC.

B. Unless otherwise noted, install indoor free standing enclosures on 4-inch concrete pad. Extend pad 4 inches beyond outside dimensions of base, all sides. Lay grout after enclosure sills have been securely fastened down.
C. Unless otherwise noted, install outdoor free standing enclosures on a reinforced concrete pedestal:
    1. Minimum Thickness: 8 inches with No. 4 steel reinforcing bars at 12-inches on centers, each way.
    2. Minimum Size: 4 inches larger than outer dimensions of base, all sides.
    3. Provide excavation and backfill work in conformance with Section 31 23 00, Structural Excavation and Backfill.
    4. Provide concrete work in conformance with Section 03 30 00, Cast-In-Place Concrete (Large Projects).
    5. Seal the contact surface between the enclosure base along the outside perimeter of the enclosure using RTV sealant.
    6. Install anchor bolts and anchor in accordance with Section 05 05 19, Anchor Bolts, Toggle Bolts and Concrete Inserts.
D. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as shown on the Drawings.

E. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.

3.5 RECORD DRAWINGS

A. Maintain a set of red-line enclosure drawings to reflect changes or deviations that occur during installation, start-up and commissioning and incorporates these deviations into the final Operation & Maintenance manual.
B. Provide record drawings in accordance with Section 01 78 39, Project Record Documents.

3.6 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, identical and interchangeable with similar parts furnished under this Specification. Comply with the requirements of Section 01 78 43, Spare Parts and Maintenance Materials.
B. Pack spare parts in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
C. The following constitutes the minimum spare parts:
    1. Five of each type of control relay for each 40 or less furnished for this Contract.
    2. One replacement power supply for each type and size furnished for this Contract.
    3. One per ten (two, if fewer than twenty) of each type of enclosure mounted instrument including lights and pushbuttons.
    4. One dozen of each type and size of fuse used in enclosures and instruments.
D. The following constitutes the minimum test and calibration equipment:

1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors.
2. All special calibration equipment required for system calibration.

++ END OF SECTION ++

SECTION 28 20 00

CCTV SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as necessary to perform the security work as shown on drawings and as specified.
   2. The Drawings and Specifications do not necessarily include every item of work. It is the intent of the Drawings and Specifications that all software, equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.

B. Definitions:
   1. The following list of terms as used in this Section shall be defined as follows:
      a. ACS – Access Control System
      b. IPCAM – Internet Protocol Camera
      c. Connect – install all necessary patch cords or other wiring necessary to complete installation
      d. IDS – Intrusion Detection System
      e. LAN – Local Area Network
      f. NVMS – Network Video Management System
      g. NVR – Network Video Recorder
      h. Owner – City of Phoenix
      i. Provide – to furnish, install, connect, test, and turn over to the Owner, compete and ready for operation
      j. PTZ – Pan Tilt Zoom
      k. SMS – Security Management System
      l. VMS – Video Management System
      m. WAN – Wide Area Network

1.2 QUALITY ASSURANCE

A. Design, installation, and operation of the Internet Protocol Camera System (IPCAM) shall conform to the following referenced codes, regulations and standards at a minimum as applicable:
   1. UL 497 Protectors for Paired Conductors Communications Circuit
   2. UL 444 Communications Cables
   3. UL 1863 Communications Circuit Accessories
   4. UL 1066 Low Voltage AC & DC Power Circuit Breakers Used in Enclosures
   5. UL 1778 Uninterrupted Power Supply Equipment
   6. UL 1651 Optical Fiber Cable
   7. UL 983 Surveillance Camera Units

8. UL 60950 Information Technology Equipment Safety
9. UL 2802 Standard for Performance Testing of Camera Image Quality

B. Permits and Inspections:
   1. Material and workmanship shall conform to all applicable legal and code requirements, and as specified in the Contract Documents.
   2. Perform all tests required to demonstrate conformance with the Contract Documents.

C. Job Conditions:
   1. Ensure that all conduits, junction boxes, outlets, and other openings are kept covered to prevent foreign matter entry.
   2. During installation ensure all equipment is kept safe from dirt, water, or other materials that could damage it.
   3. The installation is to be supervised on a regular basis by a person designated by the CONTRACTOR. This person shall be authorized and shall be competent to oversee the project.

D. This section does not detract in any way with Quality Assurance Provisions of Section 28 05 01, Integrated Security Management System – General Requirements.

1.3 SUBMITTALS

A. Refer to Section 28 05 01, Integrated Security Management System – General Requirements.

B. Submit all items in accordance with the requirements of Division 1, Submittals, and shall include, but not be limited to the following:
   1. Model numbers of all components furnished on the job
   2. Manufacturer’s Installation Instructions
   3. Manufacturer’s catalog data sheets for all components
   4. Input power requirements for all components
   5. Complete engineered drawings indicating:
   6. Layout, wiring diagrams and dimensions.
   7. Point-to-point wiring diagrams for all devices
   8. Termination details for all devices
   9. Single-line system architecture drawings representing the entire system.
   10. Testing Procedures
   11. Warranty documentation

C. Training Syllabus: Include course outlines for each of the end user training programs. The course outlines shall include the course duration, location, prerequisites, a brief description of the subject matter, and the name of the factory certified instructor who shall present the training.

D. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the

documentation shall be provided at no additional charge, in the same quantities as originally required. Each Division shall define the initial quantities.

1. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator responsibility and authority.
2. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.
3. Alarm Monitoring Manual - Step by step guide and instructions detailing all alarm monitoring system user functions and responsibilities.
4. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.
5. Complete backup of all initial system programming shall be provided with the system documentation.

1.4 MAINTENANCE

A. Provide off-line maintenance aids and on-line diagnostics to check the performance of the system interfaces and devices.

1.5 SYSTEM ACCEPTANCE

A. Refer to Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

1.6 WARRANTY

A. Guarantee all labor, workmanship and materials for a period of one year from the date of final acceptance. Should a failure occur with the first year to the IPCAM or any of it's components, the CONTRACTOR shall provide all labor and materials necessary to restore the system or component to a complete operating condition at no cost to the OWNER.

B. Honor any extended warranties provided by the equipment manufacturers.

PART 2 - PRODUCTS

2.1 SYSTEM FUNCTIONAL REQUIREMENTS

A. Although this System Scope is intended to cover all aspects of the project, the owner, at his own discretion, reserves the right to negotiate changes, additions, and deletions to the scope of this project. Any changes to scope will result in price change negotiation with the CONTRACTOR.
   1. This project requires new PTZ and fixed cameras to be added to the security system as per design. All cameras shall be available for viewing and control locally on the DAQ, as well as, from remote monitoring sites as determined by the OWNER.
   2. Cameras shall be added and positioned as per drawings.

3. Operators shall have the capability to control the PTZ cameras through the SMS workstations.
4. The completed installation shall be fully functional with approved components. No custom design shall be allowed without prior written approval from the owner or his representative. Provide a project plan to indicate time lines for completion with the bid.
5. This CONTRACTOR is responsible for coordinating all cable, conduit, pull boxes, connectors, junction boxes, terminations, x-ray, coring, permits, etc. with the Division 26 CONTRACTOR.
6. All work must be done within the scope of applicable Local, State & Federal Electrical & Building codes. Appropriate Municipal permits are to be drawn and submitted to the client or their chosen representative prior to commencement of project. Successful bidder shall have all work performed by licensed technicians only. All Technicians/subcontractor(s) working on site must be licensed to perform their work. The successful bidder and their subcontractor(s) must be licensed L11 Electrical Contractor with the State of Arizona.

2.2 INDOOR FIXED CAMERAS

A. Camera shall be a fixed (NON-PTZ) IP camera with the following operational characteristics:
   1. 1920x1080 (1080p) to 320x240 resolution or better.
   2. Pan: 105°, Tilt: 85°, Rotate: 175°.
   3. 2.8 mm, F2.0 – Horizontal field of view: 106° - Vertical field of view: 59°.
   4. Minimum 0.25 lux at 50 IRE F2.0.
   5. Fixed focus, fixed iris 1/3” progressive scan RGB CMOS.
   6. Acceptable Product Manufacturer: AXIS or pre-approved equal. IPCAM Manufacturer must be compatible with VMS manufacturer.

NOTE: If operation characteristics is not available, please advise camera specs from Network Security Group.

2.3 OUTDOOR FIXED CAMERAS

A. Camera shall be a fixed (NON-PTZ) IP camera with the following operational characteristics:
   1. 1920x1080 (1080p) to 160x90 resolution or better.
   2. Automatic day/night mode (color/black white).
   3. Pan: 360°, Tilt: 80°, Rotate: 175°.
   4. Vertical field of view: 57°-21°.
   5. 22 mm: HDTV 1080p 25/30 fps with Forensic WDR and Lightfinder.
   6. Varifocal, Remote focus and zoom, P-Iris control, IR.
   7. Camera to be mounted in an extruded and die-cast aluminum wall mount housing meeting NEMA 4 and IP66 standards, with a heater & blower.
   8. Acceptable Product Manufacturer: AXIS or pre-approved equal. IPCAM Manufacturer must be compatible with VMS manufacturer.

2.4 PAN TILT ZOOM CAMERA

A. Camera shall be of a “217 x 188 x 188 mm” Color White (Day/Night) IP Camera unitized dome design featuring Ethernet transmission capabilities. The PTZ Domes required for this site shall have at a minimum the following operating characteristics;
   1. Minimum 1920x1080 (HDTV 1080p) to 320x180.
   2. Minimum 256 presets.
   3. Minimum SD card and network share.
   4. Open API for software integration, including VAPIX and AXIS Camera Application Platform
   5. 30x optical capability.
   6. 12x digital zoom, total 360x zoom
   7. Lens focal 4.3–129 mm, F1.6–4.7 (Autofocus)
   8. Excellent light sensitivity
   9. Pan 360° endless, 0.1°/s–350°/s
   10. Tilt: 180°, 0.1°/s–350°/s
   11. Guard tour, control queue, on-screen directional indicator, set new pan 0°
   12. Auto iris, automatic gain control.
   13. Operating temperature:
      a. Indoor units: 32 to 132° F (0 to 55° C)
      b. Outdoor units: -29 to 165° F (-34 to 74° C)
   14. Power PoE+ midspan 1–port: 100–240 V AC IEEE 802.3at Type 2 Class 4
   15. Error, moving, preset reached, ready technology.
   16. Memory 512 MB RAM, 256 MB Flash
   17. Provide absolute positioning information to VMS.
   18. Acceptable Product Manufacturer: AXIS or pre-approved equal. IPCAM Manufacturer must be compatible with VMS manufacturer.

2.5 ENVIRONMENTAL ENCLOSURE

A. Domes shall include an environmental housing with heater/blower functions. Dome enclosures shall be vandal resistant and rated for corrosive and caustic environments as required. Dome enclosures mounted on an open perimeter shall be bullet resistant.

B. Outdoor cameras are to be mounted in an extruded and die-cast aluminum wall mount housing meeting NEMA 4X standards, with a heater & blower

2.6 BRACKETS

A. Camera to be mounted in an extruded and die-cast aluminum wall mount housing meeting NEMA 4X standards.

2.7 POWER SUPPLY

A. Power supply for the cameras shall be Outdoor Midspan 30W 1-Port unit, installed in a lockable cabinet conforming to appropriate UL standards, as shown in the drawings.

2.8 INFRA RED ILLUMINATOR

A. The IPCAM System will require infrared illumination at points as noted on the Drawings. The IR illuminators will provide covert and semi-covert operations allowing night viewing of up to 800 feet, with certain configurations, in 730 and 830 nanometer filtering.
   1. Beams will be available in various configurations, range of reach 150 m (492 ft) or more depending on the location.
   2. Consumption: typical 14 W, max 25 W
   3. Operational Lifetime: 5 years
   4. Temperature Range: -50 deg C to +45 deg C (-58 deg to +113 deg F).
   5. Power Supply: High Outdoor PoE midspan 1-port: 100-240VAC, max 74 W.
   6. Photocell: Dawn/dusk automatic switching.
   7. Acceptable Product Manufacturer: Extreme IPCAM or approved equal.

NOTE: If operation characteristics is not available, please advise camera specs from Network Security Group

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall include the appropriate equipment and shall be performed by a factory-trained and certified contractor. The installation shall be completed to these specifications and project plans as required by the OWNER. The installation shall include the following:
   1. Site planning and system configuration of field hardware. Consult with the OWNER, NETWORK SECURITY GROUP, and ENGINEER for final required camera settings and placements, home positions, alarm positions, and pan/tilt/zoom settings
   2. Complete system setup at the Head End and workstations.
   3. Setup of specific network software configuration requirements.
   4. Complete system diagnostics verification.
   5. Complete system operation verification.
   6. Problem reporting and tracking.
   7. Project specific installation log.
   8. Completion of specific City of Phoenix acceptance test plans.
   9. Formal turnover of the specific project installation documentation to the NETWORK SECURITY GROUP.

B. All wire and cable shall be labeled with an appropriate identification code attached to the cable near the termination. This code shall indicate the source camera. Codes shall be similarly addressed in the as built drawings.

C. All exterior cabling must be suitably enclosed to protect it against the elements as well as physical damage. Pull string or mule tape shall be installed in all conduit runs. All cabling where otherwise exposed to the employees or public, must be enclosed in conduit.

D. No splicing of cabling is permitted, except where new cable intercepts existing cabling. All splices are to be shrink-wrapped. Splices shall be contained within a

lockable metal cabinet and must be clearly labeled as to which camera or device they are wired to.

3.2 PROGRAMMING

A. Programming of the IPCAM System shall be as per Section 28 23 00, Video Management System

3.3 FIELD QUALITY ASSURANCE

A. Performance Specification Requirements: Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated. General overall performance of a product is implied where the product is specified for a specific application. All equipment to be installed per applicable UL listing for that device or component.

B. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

3.4 SYSTEMS ACCEPTANCE TESTING

A. Acceptance testing shall be per Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

B. Do not test any systems without an OWNER witness on site to observe the means in which the system is being tested. All tests that occur without an OWNER witness shall be retested by the CONTRACTOR. Retesting of a system shall not be a basis of extra payment or extension of Contract completion time.

3.5 TRAINING

A. Provide training in accordance with Section 28 08 13, Integrated Security Management System – Training.

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SECTION 28 23 00

DIGITAL VIDEO MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as necessary to perform the security work as shown on drawings and as specified.
   2. The Drawings and Specifications do not necessarily include every item of work. It is the intent of the Drawings and Specifications that all software, equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
   3. The system shall consist of a fully automated and integrated network video management system.

B. Definitions:
   1. The following list of terms as used in this Section shall be defined as follows:
      a. Head End – The Head End is a component of the Security Management System, which includes software, software licensing, file servers, and other components that are part of an Enterprise Security System previously installed by City of Phoenix Water Services. It is intended that the NVMS shall integrate fully with the Head End as described in these specifications.
      b. ACS – Access Control System
      c. IPCAM – Internet Protocol Camera
      d. Connect – install all necessary patch cords or other wiring necessary to complete installation.
      e. IDS – Intrusion Detection System
      f. LAN – Local Area Network
      g. NVMS – Network Video Management System
      h. NVR – Network Video Recorder
      i. OWNER – City of Phoenix
      j. Provide – to furnish, install, connect, test, and turn over to the OWNER, complete and ready for operation.
      k. PTZ – Pan Tilt Zoom
      l. Security System Subcontractor – Security system installer, the successful bidder on this project
      m. SMS – Security Management System
      n. VMS – Video Management System
      o. WAN – Wide Area Network.

1.2 QUALITY ASSURANCE

A. Design, Installation and Operation of the Network Video Recorder (NVR) shall conform to the following referenced codes, regulations and standards as a minimum as applicable:
   1. UL 497 Protectors for Paired Conductors Communications Circuit.
   2. UL 444 Communications Cables.
   3. UL 1863 Communications Circuit Accessories.
   4. UL 1066 Low Voltage AC & DC Power Circuit Breakers Used in Enclosures.
   5. UL 1778 Uninterrupted Power Supply Equipment.
   6. UL 1998 Software in Programmable Components.
   7. UL 1651 Optical Fiber Cable.
   8. UL 983 Surveillance Camera Units.
   9. UL 60950 Information Technology Equipment Safety.
   10. UL 2802 Standard for Performance Testing of Camera Image Quality.

B. Permits and Inspections:
   1. Material and workmanship shall conform to all applicable legal and code requirements, and as specified in the Contract Documents.
   2. Perform all tests required to demonstrate conformance with the Contract Documents.

C. Job Conditions:
   1. Ensure that all conduits, junction boxes, outlets, and other openings are kept covered to prevent foreign matter entry.
   2. During installation ensure all equipment is kept safe from dirt, water, or other materials that could damage it.
   3. The installation is to be supervised on a regular basis by a person designated by the CONTRACTOR. This person shall be authorized and shall be competent to oversee the project.

D. This section does not detract in any way with Quality Assurance Provisions of Section 28 05 01, Integrated Security Management System – General Requirements.

1.3 SUBMITTALS

A. Submit all items in accordance with the requirements of 28 05 01, Integrated Security Management System – General Requirements.

B. and shall include, but not be limited to the following:
   1. Model numbers of all components furnished on the job.
   2. Manufacturer’s Installation Instructions.
   3. Manufacturer’s catalog data sheets for all components.
   4. Input power requirements for all components.
   5. Complete engineered drawings indicating:
      a. Layout.
      b. Wiring diagrams.
      c. Dimensions.
   6. Point-to-point wiring diagrams for all devices.
   7. Termination details for all devices.
   8. Single-line system architecture drawings representing the entire system.

9. Testing Procedures
10. Warranty

C. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required. Ten copies of the following documents shall be provided to the OWNER:
   1. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator responsibility and authority.
   2. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.
   3. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.
   4. Complete backup of all initial system programming shall be provided with the system documentation.

1.4 MAINTENANCE

A. Provide off-line maintenance aids and on-line diagnostics to check the performance of the system interfaces and devices.

1.5 SYSTEM ACCEPTANCE

A. Refer to Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

1.6 WARRANTY

A. Guarantee all labor, workmanship and materials for a period of one year from the date of final acceptance. Should a failure occur with the first year to the NVMS or any of its components, provide all labor and materials necessary to restore the system or component to a complete operating condition at no cost to the OWNER.

B. Honor any extended warranties provided by the equipment manufacturers.

PART 2 - PRODUCTS

2.1 GENERAL

A. The IPCAM System shall be installed with the full support of the manufacturer of the system components.

B. The system shall consist of a fully automated and integrated network video management system, including the following:

a. Automated video surveillance of site perimeter and key areas within the site.
b. Advanced video motion analysis suitable for use in outdoor environments.
c. Video alarm monitoring and reporting of alarm and trouble conditions detected by advanced video motion analysis, sensors and/or devices.
d. Local video recording with automatic archival of video and still images associated with alarms.
e. Local video recording with automatic full time archival of video.
f. Direct camera interface to provide automated control of pan-tilt-zoom (PTZ) camera position based on time of day, video motion analysis, sensors and/or devices.
g. Fully integrated configuration of automatic camera view positioning (using advanced video motion analysis) at any nearby geographic coordinates, including arbitrary points along a perimeter, without using camera presets.
h. Fully integrated configuration of a layered and interactive Geographic Information System (GIS) data that provides operator displays of live video, camera locations, alarms, alarm locations, fence/wall perimeters, and locations of other devices overlaid on aerial imagery, street map data, and facility drawings provided by the CONTRACTOR in industry standard file formats.
i. Fully integrated configuration of alarm annunciation through e-mail, pager systems, and voice-synthesized telephony based on a hierarchical operator contact database.
j. Fully integrated configuration of left-behind or stopped object detection based on user defined parameters.
k. Fully integrated configuration of low latency PTZ camera control that provides operators with the means to position cameras both by pointing at locations on the GIS map, and by interacting with the video image itself (by clicking or dragging boxes around areas of interest).

C. System Functional Requirements:
1. Network Video Management System (NVMS):
a. The NVMS shall digitize, compress, and store video from standard analog or digital video cameras. The VMS shall provide access to video in real-time (“live”), and stored on computer-based storage devices for review at a later time.
b. NVR shall consist of rack-mountable PCs connected to a LAN and/or WAN.
c. Video and other data managed by the VMS shall be accessible from a local notebook computer and remote workstation PCs connected directly to the LAN, via a WAN and/or modem connections.
d. The VMS shall include GUI based software designed to run on PCs equipped with the Microsoft Windows 10 operating system or approved equivalent.
e. The GUI application software functions shall include system setup, administration, and monitoring; live video viewing and PTZ camera control; video playback; video export; alarm monitoring; and other capabilities as detailed in the following paragraphs. All software

applications for the VMS shall be provided with the following two modes of operation:
1) Operate as a standalone software application (for use during subsystem testing and/or maintenance purposes).
2) Operate using a common, integrated user interface that is integrated with the ACS software to achieve a fully functional SMS user interface.

2. Compatibility with Network Video Equipment: The NVMS shall be designed to work with a wide variety of IP Cameras. The system shall utilize a standard Ethernet connection for video input via TCP/IP.
3. Scalability and Expandability:
   a. Cameras: The VMS shall be scalable for any number of cameras including large sites with 100 or more cameras in a single system.
   b. Storage: The NVR shall be able to support a wide range of automated storage options ranging from as little as a few hours of online storage capacity to months of long-term storage using digital media or other cost-effective long-term storage media. The system shall have the capability of supporting unlimited video storage capacity by enabling system operators and/or automated system hardware/software and processes to periodically remove and replace removable storage media. This project requires that all recorders be sized to accommodate four (4) FPS for recording all cameras 24/7, an increased frame rate of 7.5 FPS on alarm and hard drive storage capacity for ninety (90) days of archiving recorded video at 50% alarming.
   c. The VMS shall be a distributed, multi-user, multi-tasking system capable of supporting simultaneous requests from multiple workstations.
   d. Four (4) hour minimum backup time.

2.2 MANUFACTURER

A. General:
   1. The NVR servers shall be manufactured by HP or approved equal.
   2. Pre-Approved equal.

2.3 HARDWARE

A. Network Video Recorder (NVR) (When Required):
   1. The NVR shall utilize Intel processors supporting true multi-user, multi-tasking and multi-threaded capabilities.
   2. The NVR shall be capable of running headless without monitor, keyboard, or mouse, although these will be required during installation and maintenance.
   3. The NVR shall utilize the Microsoft Windows 2016 operating system.
   4. The NVR shall be supplied with dual Ethernet network interface cards that supports 100/1000 topology. The system shall have the capability of running and supporting the TCP/IP network protocol.
   5. The NVR shall have an internal DVD-RW drive for the backup of video. The NVR shall also have the capability to plug an external drive into the USB port for additional video backup. The NVR shall be included with all necessary software to make the backup functionally complete.

6. The NVR shall be provided with 15TB of accessible fixed hard disk storage in a redundant disk RAID 6 configuration.
7. The NVR shall be capable of supporting a minimum of eight 2TB SATA hard disks in a true fully hot redundant disk RAID 6 configuration.
8. The NVR system shall be capable of accommodating upgrades in hard disk drives and RAM.

B. Workstations (When Required):
1. All client workstation software licenses will be provided by the OWNER and shall be installed by NETWORK SECURITY GROUP or CONTRACTOR on the SMS Workstation.

C. Network Switches:
1. The Core Network Switch shall be a Cisco IE 4010-165122P, or approved equivalent, with the following line cards, modules, and accessories:
   a. Catalyst 9200L 24-port data 4 x 1G, Network Essentials.
   b. IE4010/5000 Hazloc Pwr Supply High AC/DC 85-264VAC/88-300VDC.
   c. C9200L Cisco DNA Essentials, 24-port, 3 Year Term license: 36 Months
   d. IE 8 10/100,2 T/SFP, Base
   e. AC Power Module w/ IEC Plug
   f. DIN Rail Mount For 3560-CX and 2960-CX
   g. Cisco 3560CX Compact 8 ports Managed Switch
   h. Cisco Rack Mount Kit 2960 ME-3400 COMPACT SWITCH
   i. Cisco 100BASE-FX SFP for FE port TAA Compliant Transceiver
   j. Cisco 100BASE-FX SFP for FE port TAA Compliant Transceiver
   k. Cisco - SFP (mini-GBIC) transceiver module Gigabit Ethernet
   l. LC to SC single mode fiber optic patch cords.
2. The Distribution Network Switches shall be a Cisco Catalyst or approved equivalent.

2.4 SOFTWARE

A. The software system design shall be object oriented and shall be 64-bit applications running under the Windows 2010 operating systems. A service-oriented architecture shall be employed, where critical system software components are placed into independent processes to improve fault-tolerance and security. Whenever possible, these services shall run without system level privileges.

B. All system software shall have the capability of performing self-diagnostics in case of software malfunction, and whenever possible, attempt to recover from the error and resume normal operation. Self-diagnostics shall be logged into the operating system event log with stack trace analysis to identify the source code where the error occurred. Whenever possible, an alarm shall be sent to the server containing the stack trace analysis which can be used to assist in troubleshooting.

C. Security provisions within the system shall be native to Windows 2010. At the workstation, the Windows 2010 security shall be used for workstation/user authentication.

D. All client workstations and the server(s) shall have full system functionality and shall not be segregated in any way by function, except as defined by the user authentications of sign on and password.

E. The system shall have a simple, easy to use graphical user interface, and all functions shall be accessible by use of mouse and keyboard.

F. The location of GIS data on the network or local hard disk for use on the client workstation shall be configurable. The GIS data shall be stored with configuration files that determine the default visibility and position of each layer of GIS data, the maximum geographic extent to be displayed, and the local projection system to be used.

G. The workstation client application shall provide advanced user interfaces to provide low-latency control of PTZ cameras both by interacting with an interactive GIS display and by interacting directly with a live video image of a camera under operator control.
   1. The workstation client application shall allow the user to control a PTZ camera by using relative positioning commands such as tilt up, tilt down, pan left, pan right, zoom in, zoom out, focus near, focus far, iris open, and iris close. In this mode of operation, the operator needs to rely on the live video image for control feedback, which may result in lag between the operator's control signals and the camera's apparent response.
   2. The workstation client application shall allow the user to point multiple cameras simultaneously at an arbitrary location on the interactive GIS display by using the curser control to point to a specific location on the map. The user interface shall indicate the field of view of each camera on the GIS display. In this mode of operation, the operator is not relying on the live video image for feedback. Instead, the interactive GIS map shall show a camera's current field of view to provide the operator with feedback where the camera is positioned. The display of the field of view shall be proportional to the current zoom level of the camera.
   3. The workstation client application shall allow the user to control a PTZ camera by using absolute positioning commands where the user may click on an arbitrary location in the live video image, and the appropriate commands shall be sent to the PTZ camera to substantially center that point in the camera's field of view, regardless of the camera's current zoom level. In addition, the user may draw a rectangular box around a portion of the live video image, and the appropriate commands shall be sent to the PTZ camera to change the camera's field of view so that it is substantially centered on and is substantially the same size as the user defined rectangle while maintaining the aspect ratio inherent to the camera.

H. The video motion analysis software shall utilize advanced video analysis techniques, such as adaptive background modeling and subtraction and object tracking. The software shall tolerate low frequency camera vibration caused by

wind or structural movement without generating false alarms. It is not acceptable to use video motion detection based only on pixel changes, as this results in large numbers of false alarms when used in outdoor environments. The video motion analysis software shall recognize when a camera is being issued movement commands, and shall not raise events or alarms while the camera is being remotely controlled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the NVMS shall include the appropriate equipment and shall be performed by Network Security Group. The installation shall be completed to these specifications and project plans as required by the OWNER. A comprehensive OWNER site-planning guide for the NVMS shall be provided. Adherence to the specific requirements of this document will assist in ensuring a successful System installation. The installation shall include the following:
   1. Site planning and system configuration of field hardware and NVMS.
   2. Complete hardware setup of all system Workstations software and peripherals.
   3. Complete configuration of all system Workstations software, peripherals and installation of field hardware.
   4. Setup of specific network software configuration requirements.
   5. Complete system diagnostics verification.
   6. Complete system operation verification.
   7. Problem reporting and tracking.
   8. Project specific installation log.
   9. Completion of acceptance testing.
   10. Formal turnover of the specific project installation documentation to Maintenance Service Organization.

3.2 PROGRAMMING

A. Prior to the completion of installation, a meeting with OWNER shall be held to determine all the programming criteria. The issues that shall be discussed include the following:
   1. Camera naming.
   2. IPCAM call-up & recording features (including video activity detection).
   3. Alarm responses by camera.
   4. System database backup.
   5. License plate camera recording requirements.

B. Document the results of the meeting and perform all necessary programming to achieve requested changes.

C. Provide the entire programming and setup of the system such that no additional programming is required. The Network Security Group provided programming shall include the setup of all applicable features of the software.

D. Perform two full system back-ups at completion of initial programming and deliver one copy with a letter of Transmittal explaining information included in the back-up and a brief description of recovery procedures. The second backup shall be labeled “to remain onsite”. Perform back-ups as modifications to the database/programming occur through the remainder of the project.

3.3 FIELD QUALITY ASSURANCE

A. Performance Specification Requirements: Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated.

B. General overall performance of a product is implied where the product is specified for a specific application. All equipment to be installed per applicable UL listing for that device or component.

C. Comply with manufacturer’s instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

3.4 ACCEPTANCE TESTING

A. Acceptance testing shall be per Section 28 08 10 Integrated Security Management System – Start-up, Commissioning and Field Testing.

B. Do not test any systems without a Network Security Group Participant and ENGINEER witness on site to observe the means in which the system is being tested. All tests that occur without a Network Security Group Participant and ENGINEER witness shall be retested. Retesting of a system shall not be a basis of extra payment or extension of Contract completion time.

C. Test all system requirements to ensure proper operation and configuration of the network video management system. These requirements shall apply to all integrated system components and software, including, but not limited to all system computers, field controllers, card reader devices, IPCAM and equipment and interface capability.

D. Develop operational scenarios to simulate the actual use of the system in the normal environment of the facility, as part of acceptance testing. The Network Security Group and ENGINEER reserves the right to modify the test plan or require additional operational test procedures to effectively exercise all system operations.

3.5 SYSTEM TRAINING

A. Provide training in accordance with Section 28 08 13, Integrated Security Management System – Training.

+ + END OF SECTION + +

SECTION 28 30 00

INTEGRATED SECURITY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as necessary to perform the security work as shown on drawings and as specified.
   2. The Drawings and Specifications do not necessarily include every item of work. It is the intent of the Drawings and Specifications that all software, equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
   3. Device locations shown on drawings are schematic. All equipment locations, including cameras, controllers, I/O boards, servers, workstations, and all alarm and Internet Protocol Camera devices shall be field verified with the ENGINEER and/or OWNER.

B. Definitions:
   1. ACS – Access Control System
   2. IPCAM – Internet Protocol Camera
   3. Connect – install all necessary patch cords or other wiring necessary to complete installation
   4. Security System Subcontractor – Security system integrator/installer, the successful bidder on this project
   5. IDS – Intrusion Detection System
   6. LAN – Local Area Network
   7. NVR – Network Video Recorder
   8. OWNER – City of Phoenix Water Services Department
   9. Provide – to furnish, install, connect, test, and turn over to the OWNER, complete and ready for operation
   10. PTZ – Pan Tilt Zoom
   11. SCADA – Supervisory Control and Data Acquisition
   12. SMS – Security Management System
   13. SMU – Security Management Unit
   14. VMS – Video Management System
   15. WAN – Wide Area Network

C. System Intent – Electronic Security Component:
   1. It is the intent of this project to have the CONTRACTOR provide a fully integrated, turnkey security system. The electronic security component generally consists of the following elements:
      a. Access Control System (ACS)

b. Internet Protocol Camera / Network Video Record (IPCAM/NVR)
c. Perimeter Intrusion Detection System (IDS)
d. Interior Intrusion Detection
e. Network Video Recorder (NVR)

2. The ACS shall act as the overall Security Management System (SMS). It is therefore critical that the system can perform the following functions:
   a. The ability to integrate at a controller level via software with other components of the security system. This means that the SMS shall accept and provide instructions over serial and/or Ethernet data interfaces at the network controller level from the other systems. The SMS shall be capable of operating independently of the servers and workstations. The loss of a server or workstation shall not in any way degrade the functionality of the system. All interfaces between the systems shall be performed at the network controller level. All alarms shall continue to be received at the workstations via SNMP traps in the event of loss of communication with the server.
3. The SMS shall include devices and equipment to monitor and control access to restricted areas, detect and deny unauthorized entries within specific buildings or areas, annunciate alarms and generate reports. Once incorporated with the day-to-day operations of the designated facility, this system shall detect and deter unauthorized entry into restricted areas. The SMS shall be designed and configured to provide operational flexibility and reliable performance.
4. The SMS shall consist of equipment and devices placed at predetermined locations to ensure that only cardholders who are authorized to enter secured areas through certain doors or gates can do so. This shall be accomplished by means of a computer and electronic devices used in conjunction with door locks, gate systems, card readers, and/or closed circuit television, and/or intrusion detection equipment.
5. The SMS shall integrate access control, intrusion detection, IPCAM, and VMS into one coherent Security System capable of being controlled from any workstation on the system, including off site workstations. The various elements of the SMS (access control, IPCAM, intrusion detection) shall be capable of being controlled through one interface. The SMS shall have the capability to be fully monitored from either on site or off site workstations.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. National Electrical Code (NEC).
   2. UL 294 Access Control Systems.
   3. UL 1076 Line Supervision.
   4. FCC Rules and Regulations.
   5. Part 15, Radio Frequency Devices.
   6. National Electrical Manufacturers Association (NEMA).
   7. Applicable Federal, State and Local laws, regulations, codes.
   8. Americans with Disabilities Act (ADA).
   9. UL 497 Protectors for Paired Conductors Communications Circuit.

10. UL 444 Communications Cables.
11. UL 1863 Communications Circuit Accessories.
12. UL 1034 Burglary Resistant Electric Locking Mechanisms.
13. UL 1066 Low Voltage AC & DC Power Circuit Breakers Used in Enclosures.
14. UL 1778 Uninterrupted Power Supply Equipment.
15. UL 1998 Software in Programmable Components.

B. Permits and Inspections:
   1. Material and workmanship shall conform to all applicable legal and code requirements, and as specified in the Contract Documents.
   2. Perform all tests required to demonstrate conformance with the Contract Documents.
   3. Material and hardware that requires 102-volt circuit needs to be approved by the Network Security Team before installation (NFPA standards required).

C. Job Conditions:
   1. Ensure that all conduits, junction boxes, outlets, and other openings are kept covered to prevent foreign matter entry.
   2. Ensure all equipment is kept safe from dirt, water, or other materials that could damage it during construction.
   3. The installation is to be supervised on a regular basis by a person designated by the CONTRACTOR. This person shall be authorized and shall be competent to oversee the project.

D. This section does not detract in any way with Quality Assurance Provisions of Section 28 05 01, Integrated Security Management System – General Requirements.

1.3 SUBMITTALS

A. Submit all items in accordance with the requirements of Section 28 05 01, Integrated Security Management System – General Requirements and shall include, but not be limited to the following:
   1. Model numbers of all components furnished on the job.
   2. Manufacturer’s Installation Instructions.
   3. Manufacturer’s catalog data sheets for all components.
   4. Input power requirements for all components.
   5. Complete engineered drawings indicating:
      a. Layout, wiring diagrams and dimensions.
      b. Point-to-point wiring diagrams for all devices.
      c. Termination details for all devices.
      d. Single-line system architecture drawings representing the entire system.
   6. Testing Procedures
   7. Warranty.

B. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the

documentation shall be provided at no additional charge, in the same quantities as originally required. Ten copies of the following documents shall be provided to the OWNER:

1. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator responsibility and authority.
2. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.
3. Alarm Monitoring Manual - Step by step guide and instructions detailing all alarm monitoring system user functions and responsibilities.
4. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.
5. Complete backup of all initial system programming shall be provided with the system documentation.

1.4 MAINTENANCE

A. Provide off-line maintenance aids and on-line diagnostics to check the performance of the SMS interfaces and devices.

1.5 SYSTEM ACCEPTANCE

A. Refer to Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

1.6 WARRANTY

A. Guarantee all labor, workmanship and materials for a period of 1 year from the date of final acceptance. Should a failure occur within the first year to the SMS or any of its components, provide all labor and materials necessary to perform system diagnostics to isolate the source of the failure and restore the system and its components to a complete operating condition, at no cost to the OWNER.

B. Honor any extended warranties provided by the equipment manufacturers.

PART 2 - PRODUCTS

2.1 GENERAL SECURITY MANAGEMENT SYSTEM (SMS) REQUIREMENTS

A. General Requirements:
   1. SMS shall be furnished complete, installed, programmed, tested, and operational. The SMS shall be installed properly to secure the designated OWNER facilities. The work to be provided, in addition to integrating, furnishing and installing the SMS, shall include the following:
      a. Provide software that meets specified contract requirements and the necessary programming of the software.

b. This software shall be integrated into the existing Enterprise Wide Security Management System.
c. Verify that proposed equipment and devices furnished are adequate for the intended purpose.
d. Perform a layout check to ensure that adequate access is available for construction, installation and maintenance of equipment and devices furnished.
e. Perform acceptance testing to show the system is properly installed and that it meets the specifications, drawings and applicable codes.
f. Upon final acceptance of the completed system, the OWNER Systems Administrator shall be responsible for further programming and system administration functions.
g. Provide all necessary system utilities for the System Administrator to use for further programming and system administration functions.
h. Provide all necessary software for backups and log file maintenance.

2. Base System: Provide the SMS, as shown on the drawing and specifications herein, including but not limited to the following:
a. Alarm Monitoring and Display Workstation(s).
b. File Server.
c. Workstation Peripherals.
d. Access Control and Alarm Monitoring Controllers.
e. Network Controllers.
f. Site Network Controllers.
g. LON I/O Modules.
h. Field Hardware Devices.
i. Software Modules Required for Specification Operation.
j. Application Server
k. Active Directory Server
l. SQL Server

3. Provide accurate GIS maps of the entire project site and integrate the GIS maps into the VMS systems.
4. All SMS applications provided by the CONTRACTOR shall be easy, quick and efficient to use. The system shall combine keyboard and mouse operations with graphical presentations of screen information. Each application shall provide consistent user interfaces across all operations of the system.
5. Provide a SMS configuration that uses practical methods of generating help options, standard terminology, and drop down menus. All routine information displayed and requiring input shall be in English language prose. No operation shall require the interpretation of machine code and/or the use of mnemonics.

B. SMS Functional Requirements – The following SMS functional requirements include system configuration requirements that need to be performed by the CONTRACTOR; as well as, general requirements of the existing enterprise wide SMS components that the CONTRACTOR needs to know to properly integrate and configure the facilities SMS components into the overall enterprise wide SMS architecture:
1. Basic System Characteristics:

a. This system shall be based on the capabilities of Andover Controls Continuum Security Management System and the CONTRACTOR shall provide all necessary upgrades to the Andover Controls Continuum Security Management System to achieve the level of integration and functional requirements identified in this specification.
b. The SMS shall provide for full intelligent integration via open architecture using processor based control hardware and field controller, file server, and workstation based software for Access Control, Intrusion detection, IPCAM/VMS integration and photo imaging.
c. This SMS shall provide a true multi-tasking, multi-workstation client-server arrangement based on PC-based client platforms running Windows 10 operating system or approved equivalent and PC-based server(s) running Microsoft Windows Server and Microsoft's SQL Server or approved equivalent.
d. The SMS client-server arrangement shall communicate with native TCP/IP Primary Network Controllers over an Ethernet TCP/IP enterprise network.

2. Perimeter Breach:
   a. The perimeter of the site shall be protected by a combination of technologies, including fence cable, buried cable, optical beams, and video motion detection. A breach on the fence line or at the gate activates the perimeter intrusion detection system. The perimeter breach shall activate the VMS systems.
   b. The SMS controller shall interpret the event, and send information to the alarm monitoring station, to record the event.
   c. The event to the VMS shall activate specific pre-programmed cameras in the immediate vicinity of the detected breach to pan, tilt, and zoom to observe the breach. There may be multiple cameras for each area considered.
   d. The VMS shall engage its own video motion detection and, if applicable, shall create an alarm. This alarm shall also be sent to the monitoring workstation(s) for assessment and response.
   e. The operator shall have the capability of taking over full control of the IPCAM system when an alarm occurs through the graphical user interface on the monitoring workstations, but if another alarm is received the system shall have priority over the IPCAM controls.
   f. The zones of the perimeter intrusion system shall be configured to be armed or disarmed either on schedule or with an authorized card swipe via the ACS.
   g. The perimeter intrusion alarm system shall be configured to identify a breach to the perimeter within ten (10) feet of the occurrence on chain link fence. The location of this breach shall be displayed on the map with the SMS workstation graphics.
3. Access Control Alarms:
   a. The ACS component shall operate in such a fashion that any access event or alarm can be noted by the monitoring personnel, as well as forwarded via numerous technologies specified herein.
   b. The IPCAM integration capability, through the serial and/or Ethernet interface, shall instruct the VMS to operate cameras in such a way as to

provide images of the event, offer command and control, and playback review including full function control of the camera, through the VMS system.

4. Internal Building Alarms:
   a. Certain areas of the site shall have internal alarms in the form of door contacts, motion detectors (PIR) and glass break sensors.
   b. The SMS shall be used to receive and process all internal building alarms, without using a separate third party intrusion alarm panel, and the SMS shall be used to note and respond to all internal building alarms, as required by the OWNER.
   c. The SMS shall be capable of arming and disarming zones with either a valid card swipe, a schedule, or alternatively via an integrated card reader/keypad unit.
   d. The system shall also be capable of arming and disarming on schedule.
5. Gates:
   a. Exterior perimeter gates at the site are intended to require card readers to enter and exit, with the capability to employ anti-passback procedures.
6. Off Site System Monitoring:
   a. The system shall have the capability of being monitored by off site OWNER staff and on site OWNER staff with a notebook computer running the SMS software application.
   b. The CONTRACTOR shall coordinate with City of Phoenix Information Technology Services and Water Services Department to obtain the appropriate type of communications link to offsite OWNER locations.
   c. The CONTRACTOR shall be responsible for providing all necessary connections to the City of Phoenix, Information Technology Services provided communication devices. This includes furnishing and installing instrumentation cables between City of Phoenix, Information Technology Services provided communications devices and CONTRACTOR provided security system LAN devices on site, as well as furnishing and installing instrumentation cables between City of Phoenix, Information Technology Services provided communications devices and security system monitoring devices that are provided by others at off site locations, as needed, to integrate the site security system with the existing enterprise wide SMS components located off site.
   d. The CONTRACTOR shall be responsible for providing all necessary system configurations (on site and off site) to allow the off-site locations to properly monitor the on-site security system.
7. Access Control:
   a. Access Privileges - All cardholders shall have facility access based on privileges assigned by controlled area, time and date. For example, some badges shall only allow access to the facility on weekdays between 8:00 a.m. and 5:00 p.m., while others allow access on weekends between 1 p.m. to 5 p.m. and so on. These time zones for each day are to be pre-defined by COP and shall have the capability to be modified quickly by authorized employees without vendor

intervention. There shall be an unlimited number of user-definable access privileges.

b. Holidays - The holidays application shall allow the System Administrator to create holiday schedules that designate individual days as holidays, or special days to cover vacations, maintenance shutdowns, or other events, indefinitely into the future. Holidays or special days can signal that the system shall operate on a schedule different from the normal schedule. The system shall not limit the number of holiday or special schedules that can be created.

c. Time / Date - The time and date of the system shall be set by a centralized time synchronization system set up by the City of Phoenix. Dates for Daylight Savings Time shall automatically take effect by time zones. Holiday schedules shall override normal schedules in effect.

d. Global Data Exchange and Operating Strategies - The SMS shall provide global data exchange and operating strategies. The system shall allow any input point configured in the system (i.e., door tamper, duress, etc.) to permit activation of any control output point, such as a relay(s) that opens a door and/or sounds an alarm. The logic shall be developed using an application programming language that can incorporate other parameters such as date and time; it shall not be limited by a fixed number of rules, or the simple linking of inputs to outputs. The global operating strategies feature shall provide the ability to drive any system output or outputs from single or multiple inputs, access events, alarms, etc. Each output point shall be controllable by the system and be configurable individually for the following responses:

e. Output relays (and groups) shall have the capability of responding to:
   1) Input alarms from any I/O module or card reader point in the system, or any combination thereof.
   2) Access events.
   3) Date and time parameters.

f. Output relays (and groups) shall be capable of:
   1) Pulsing for a predetermined duration; duration shall be programmable for each relay individually.
   2) "Following" any input point from any I/O module, or card reader input in the system (on with alarm, off when clear, or as required).
   3) Locking On with alarm, requiring user intervention to reset the output relay.
   4) The system shall permit output relays to be ordered on, off, pulsed or reset back to a default setting.

8. Shunt Time:
   a. Shunt Time feature shall be provided to allow users to program, at the door level, a length of time to hold a door open without creating an alarm condition at the monitoring workstation. The shunt time feature shall be usable by any cardholder with an active badge and appropriate access rights. Valid open times shall range from 0-9999 seconds. If the door fails to close prior to the expiration of the shunt period, a "door held open" alarm shall occur at the system's monitoring workstation. If the door is closed prior to the expiration of the shunt period, the door

position switch shall become active immediately, allowing a “door forced open” alarm to be annunciated in the event of an intrusion.

9. Area Control:
    a. The SMS shall provide five (5) area control features: Hard Anti-passback, Soft Anti-passback, Timed Anti-passback, Multiple-Man Rule, and Occupancy Limit. Area control shall be a security method of preventing a person from passing their badge to another person for dual entry into a location utilizing one card.
        1) Hard Anti-passback - The Hard Anti-passback feature shall require that a badge always be used to enter and exit an area. Areas shall be logically defined under the SMS, and area control shall not be required at all areas of OWNER facility to be utilized. The system shall allow persons whose cards are appropriately configured to be exempt from this feature as configured by the System Administrator.
        2) Soft Anti-passback - The Soft Anti-passback feature shall require that a badge be used to enter and exit an area, but access shall not be denied if the badge was not presented in the correct order. The system shall automatically generate an anti-passback violation event and can trigger an alarm to be generated. The controlled areas shall have both entry and exit readers at all portals. When a cardholder uses a card reader for entrance, and has not swiped out, an anti-passback alarm shall notify the user. Areas shall be logically defined under the SMS, and area control shall not be required at all areas of the facility to be utilized. The system shall allow persons whose cards are appropriately configured to be exempt from this feature as configured by the System Administrator.
        3) Timed Anti-passback - This anti-passback feature shall allow the System Administrator to decide how long after a cardholder has swiped will they have to wait before the same card will be accepted again at the same reader, or globally at any other reader defined in the area. This helps prevent multiple swipes by an individual to allow access to others through turnstile doors.
        4) Multiple-Man Rule - shall be provided through application programming to restrict access to certain areas unless there is more than one cardholder present. Individual exit shall be permitted until the required number of people to originally gain access is reached, at which point the Multiple-Man Rule applies for exiting.
        5) Occupancy Limit - Occupancy Limit shall restrict the number of cardholders that will be present in an area at any given time. The Occupancy Limit shall be able to be defined by the System Administrator for each controlled area. Each area for which Occupancy Limit is enabled shall be definable at all controlled areas equipped with entry and exit card readers.
10. Remote Dial-Up and Internet Communications:
    a. The SMS network/site controllers and NVR components at the site shall be capable of being connected to the enterprise wide SMS components

located off site via a secure dial-up communications link and a WAN communications link. The SMS shall allow a modem on a remote SMS workstation to communicate with site components via a serial/ethernet connection to the network controller(s) at the site.

b. The enterprise wide SMS components located off site shall initiate communications to the network and site controllers under the following conditions:
   1) Upon user request.
   2) At preconfigured intervals.
   3) When access control configuration changes are made.
   4) When changes in cardholders are made affecting the remote field controllers.

c. The NET controller(s) at the facility shall initiate communications to the remote enterprise wide SMS component under any of the following conditions:
   1) At preconfigured intervals.
   2) When specific events occur on the field hardware.
   3) When the event buffer reaches a configured percentage of capacity.
   4) When specific event/alarm types occur (e.g.: access denied).

d. One (1) standard dial-up telephone line per remote site shall be required and will be provisioned by the OWNER, regardless of the number of network/site controllers and I/O modules.

11. Manual Control:
    a. A user shall have the capability to easily dictate manual control of all output points connected to the system via color graphic maps. Control points are defined as any door strike or any other relay output point of an I/O module. The System Administrator shall have the option to group these outputs to simplify common output command procedures.
    b. All system outputs shall display upon command from the user in a list window or graphic map. The list of commands shall be operational without interfering with alarm monitoring operations. If an output is ordered to a setting, and is also on time zone control, the last command shall always override.
    c. All manual control commands shall be recorded into the activity log for viewing by any user given proper privileges to do so.
    d. Manual control for doors, or any relay output, shall allow the user to disable the door/output (to not accept any cards), unlock the door/output (leaving the door strike unlocked), pulse the door/output open or reset the door/output to a pre-defined default setting.
12. Arm-Disarm:
    a. The user shall have the capability to determine the current status (armed or disarmed) as well as the current state (alarm/normal/fault) of an input point from an input list view at any time.
    b. The user shall have a “Status” item in the list view. Both the current status and state shall be reflected by the color of the respective columns in the list view.
    c. Arm-Disarm shall be accomplished by a user through a simple click of the mouse on the individual point. Once a user arms an input point,

events from the respective area permit the display of alarms at an alarm monitoring workstation from that point forward.

d. All input points shall be grouped for ease of operation into arm-disarm groups.
e. Arm-Disarm list views shall be viewable at any time.

13. Alarm Management:
    a. The SMS software shall have the capability of accepting alarms directly from controllers, or generating alarms based on polling of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) shall be integrated into the overall alarm management system and shall appear in all standard alarm reports, be available for user acknowledgment, and have the option for displaying graphics, or reports. Alarm management features include:
        1) Minimum of 255-alarm notification levels. Each notification level shall establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.
        2) Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username, time of acknowledgement, and time of alarm silence (soft acknowledgement).
        3) Automatic printing of the alarm information or alarm report to an alarm printer or report printer.
        4) Sounding of an audible beep or playing an audio (.wav) or displaying a video (.avi) file on alarm initiation or return to normal.
        5) Sending an email and/or alphanumeric page to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because a user has not acknowledged the alarm within a user-configurable timeframe.
        6) The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required.
        7) Sending a text message to an alphanumeric pager compliant with the TAPI protocol.
        8) Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, an invalid card read alarm can be configured to be routed to a system administrator workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
        9) An active alarm viewer shall be configured for each user or user type to hide or display any alarm attribute, including the following:
            a) Date / Time of Alarm.
            b) Name of Alarm.
            c) Priority of Alarm.
            d) Type of Alarm.
            e) Alarm Message.

f) User Text Input.
g) User Action Drop-down list.
h) Acknowledged by.
i) Date / Time of Acknowledge.
j) Silenced By.
k) Date / Time of Silence.

b. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.
c. The active alarm viewer shall be configured for critical alarms such that a user is required to type in text in an alarm entry field and/or pick from the user action drop-down list. This ensures accountability (audit trail) for the response to critical alarms.
d. The user shall have the capability to Soft Acknowledge (Silence) or Acknowledge the alarm, each of these actions shall be logged and date/time stamped.
e. Each alarm shall be configured to be acknowledged under the following:
   1) Acknowledge all the same alarm type.
   2) Acknowledge all the same alarm types until a specified time.
   3) Acknowledge only highlighted alarm.
f. The user shall have the capability to configure how alarms are removed from the active alarm view based on the following:
   1) Acknowledged.
   2) Return to Normal.
   3) Acknowledged or Return to Normal.
   4) Acknowledged and Return to Normal.
   5) Acknowledged after Return to Normal.
g. The user shall have the capability to highlight a specific alarm and select a button to display an associated graphic map, or select a button to display an associated report.
h. Each alarm event shall be configured as either Single Entry or Multi-Entry. Alarm events that occur for the same point going into and out of the active alarm state may be designated as Single Entry and displayed in the active alarm view once only. Each time the alarm occurs, the time/date stamp of the single entry shall update in the active alarm view. In addition, each individual alarm event shall be logged into history with all respective times of occurrence. Alarm events designated as Multi-Entry shall be shown in the active alarm view and in the alarm history log for each occurrence.
i. Other alarms shall be displayed by the system while any alarm is being addressed. If another alarm occurs, the alarm pending counter shall increase by one, the new alarm shall enter the alarm list box prioritized in an order as defined by the System Administrator.

14. The SMS shall allow journals to be retrieved, viewed and edited on screen. Journals shall be saved to DVD or External Hard Drive during back-ups for a permanent record as required by OWNER regulations.
15. Current Status Indication - The active alarm view shall provide a status indicator that displays the current status of alarms and field controllers.

Selecting the graphic icon shall provide the user with a detailed list of the groups of devices offering a dynamic list view of the current status of the respective points.

16. Cardholder Record Call-up - The enterprise wide SMS components can allow a user to initiate the call-up of a cardholder record. This feature is provided at all Alarm and Display Monitoring Workstations to assist the user in determining access rights for an employee who may have forgotten his or her badge.
17. Utilizing a database search via the input of the cardholder's name, or other key search fields, the enterprise wide SMS components can provide access of the employee's personal file, containing pertinent information and the employee's image for identification by the user. This operation does not restrict the operation of monitoring alarms.
18. IPCAM/Image Comparison:
    a. The recall of photo images taken by the SMS may be displayed in response to a card read alarm (e.g.: access denied, out of time zone, no access to area, badge voided, etc.), or any condition for that matter, at any user workstation. This shall be accomplished by selecting the event desired and displaying the record of the cardholder selected.
    b. The enterprise wide SMS components shall be configured to automatically call-up a camera located near the card reader in alarm, implement the appropriate camera pre-set position, and display the live IPCAM image on the workstation, or an adjacent video monitor for user comparison of the images.
    c. This shall allow immediate user comparison of the cardholder at the reader and the image on record for the card number.
    d. The enterprise wide SMS components shall be configured to provide a SMS user with the option to pulse the door/gate open, for the cardholder from this SMS workstation application window.
19. Cardholder or Card Reader Trace - The enterprise wide SMS components can allow a user to initiate several cardholder traces and/or card readers while monitoring alarms. This information is continuously accumulated in the trace window until the trace is stopped. The trace operations do not interfere with the operation of the alarm monitoring, and is continuous while alarms are monitored. Each trace operates independently, such that one trace may stop and start without interfering with another. A list of the last 25 access event transactions may be available in each personnel record.
20. Automatic User Logoff - The system shall automatically log the user out of the application after a specified period of inactivity, including keyboard input and mouse movement. The user shall have to log back into the system to handle an alarm. This feature shall be configurable on a workstation-by-workstation basis by the system administrator.
21. IPCAM/VMS Interface:
    a. The SMS shall be configured for automated control via an interface with the Internet Protocol Camera (IPCAM) System and Video Management System (VMS) installed. When the SMS receives an alarm from any monitoring point connected to the system, the SMS shall send any required number of control commands relating to that alarm point to the VMS System. These commands shall instruct a IPCAM camera view to

be displayed on the Workstation or the programmed monitor. The SMS shall be configured for the following signals to be sent per alarm input zone or card access alarm:

1) Receipt of alarm at the SMS Alarm Monitoring and Display Workstation shall allow events to be viewed as alarms and shall initiate a sequence of events including the call-up of the camera to view the alarm area.
2) Alarm acknowledgment or clearing the alarm shall allow the camera to be setback to reset positions or normal operation automatically.

b. The IPCAM/VMS system shall be configured to interface the ACS via a serial and/or Ethernet data link to an ACS Network Controller; as well as, a user Workstation/notebook computer via RS-232 or TCP/IP, as applicable.

22. Receipt of site alarms at the enterprise wide SMS Alarm Monitoring and Display Workstations shall allow events to be viewed as alarms, and shall initiate a sequence of events including the call-up of the camera to view the alarm area and starting of the VMS to record the alarm event. Alarm acknowledgment or clearing the alarm shall allow the camera, monitor and VMS to be setback to reset positions or normal operation automatically.
23. Scheduling:
    a. Time of day schedules shall be in a calendar style and shall be programmable up to ten years in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a specific day even from the yearly view.
    b. To change the schedule for a specific day, a user shall simply click on the day and then click on the day type.
    c. Each schedule shall appear on the screen viewable as an entire year, month, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
    d. Schedules shall be assigned to specific controllers and stored in their local RAM memory.
    e. Any changes made at a workstation shall be automatically updated to the corresponding schedule in the controller.
    f. Schedules shall be downloaded to the respective controller on a weekly basis.
24. Cardholder Management and Enrollment:
    a. All Cardholder Management and Enrollment is provided by the other system components that are not part of this project.
    b. The SMS shall be integrated to the Cardholder Management and Enrollment Head End system.
    c. The SMS shall have the capability of receiving and using all cardholder information generated elsewhere on the Enterprise System.
    d. The SMS shall allow cardholder management from any workstation that is part of the project.
25. Search Records:

a. The SMS shall allow the user to search for records and images using search criteria on any field(s) in the database.
b. The user shall be able to enter the search criteria for one or a combination of fields.
c. The user shall be able to perform partial searches by typing a wild card symbol (*) at the end of a partial string. For example, a partial string search on Smi* might return "Smiley," "Smith," or "Smitts." Using the wildcard symbol alone in a key field (i.e. typing an asterisk in and selecting the search function) shall return every record in the database which contains information in the respective field.

26. System Administration:
    a. The SMS workstation software uses Windows Explorer-style configuration interface for a system administration user or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. This interface shall be configured to present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure.
    b. The workstation software configuration interface also includes support for template objects as follows:
        1) Template objects shall be used as building blocks for the creation of the SMS database.
        2) The types of template objects supported shall include all data point types (input, output, string variables, etc.), Personnel records, doors, alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs.
        3) Groups of template object types shall be set up as template systems and subsystems.
        4) The template system shall prompt for data entry. The template system shall maintain a link to all “child” objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change.
        5) This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the SMS.
    c. The CONTRACTOR shall coordinate with the OWNER representatives when assigning object names and filename conventions to be consistent with other existing conventions in the enterprise wide system.
    d. The SMS shall allow all objects (door, personnel record, alarm, etc.) to be created with a unique 128-character name to provide the user with a fully descriptive object identifier.
    e. The system shall automatically create up to a 16-character alias from the object name to simplify the object's use in reports, applications, programs, and alarms, for example.
    f. System administration is intended to be performed from the enterprise wide SMS components located off site.
27. Workstation and Password Privileges:

a. Workstation and password privileges shall be coordinated with the OWNER.

28. Create and Maintain Door Objects:
    a. The CONTRACTOR shall create door/gate objects using templates (as described in the System Configuration section) or by direct input by the user. The door object editor shall be tabular in design for easy navigation through the attribute fields.
    b. The SMS shall be configured to allow a user to do the following from the door record:
        1) Document a description of the door.
        2) View or change the door's current state from unlocked to locked and vice-versa.
        3) Momentarily unlock the associated door.
        4) View the state of the door switch.
        5) Enable or disable the door state.
        6) Specify up to four (4) acceptable site codes.
        7) Designate a general PIN.
        8) Choose between Wiegand or ABA card type and select the appropriate bit format.
        9) Associate door hardware wiring to the appropriate input/output channels.
        10) Specify whether the door shall lock or shall not lock upon closure.
        11) Attach specific door unlock and door lock schedules.
        12) Define anti-passback rules.
        13) Define readers and attach associated controlled areas.
        14) View a dynamically updated list of the last 25 events associated with the door.
29. User Activity Logging:
    a. The SMS system can provide full user activity tracking of all keyboard functions. The SMS shall be configured to record all changes to the database fields made by any user.
    b. SMS shall log over 200 separate functions, including:
        1) User Log-in and User Log-out.
        2) Additions, Changes, and Deletions to Cardholder Management.
        3) Temporary Pass Add and Delete.
        4) Other critical database functions.
    c. SMS shall be configured to log all activity including alarms, alarms acknowledged, cleared, output control activity, trace, and other functions associated with the site. The SMS shall log a minimum of 1,000,000 events before the system history overwrites the oldest data.
    d. The SMS shall be configured to provide a user activity report to query the information available in the SMS System activity log. The report shall be sorted by workstation, user, date and time or other selection criteria. On those occasions when historical data shall be needed, the user activity report shall be generated from an archived log as well as from the active SMS database.
30. Screen Format Design:
    a. The screen format design for the site shall be consistent with other remote sites.

b. Sixty-four (64) user-defined data fields shall be available.

31. Integrated Development Environment:
    a. Each Alarm, Display, and Integrated workstation shall be equipped with an integrated development environment (IDE) to allow only the Systems Administrators the ability to write, edit, and de-bug the application programs resident in the network and site controllers.
    b. The IDE allows the display of multiple windows of application programs so Systems Administrators can quickly and easily “copy and paste” programming code using simple mouse clicks from one to another.
    c. The IDE shall provide a tool set to allow users to quickly access libraries of commonly used object names, functions, values, and application programming keywords.
    d. An IDE wizard shall be provided that will permit the use of pre-written application programs and creation of new programs that prompt for key values and create the program code automatically.
32. Reports:
    a. The SMS shall have the capability to provide, as a minimum, the following standard reports as required for the project:
        1) User Activity Log.
        2) Alarm History Log.
        3) Door Status Report.
        4) Alarm Point Status Report.
        5) Controller Status Report.
        6) Workstation Status Report.
        7) Event History Log.
        8) Invalid Attempt Log.
        9) Valid Access Log.
        10) All Personnel Report.
        11) Disabled Personnel Report.
        12) Personnel By Department Report.
        13) Personnel By Area Privileges Report.
        14) Lost Card Report.
        15) Input/Output Status Report.
        16) Schedules Report.
        17) Company Listing Report.
        18) Termination Report.
        19) Badge Pending Expiration Report.
        20) Cards Not Used in X days (Deadbeat Report).
        21) All Doors Report.
        22) All Events Sorted By Door.
        23) All Events Sorted By Person.
        24) Anti-passback violation.
        25) Muster.
        26) Area loading.
    b. Each report shall be configured to print the date and time that the report was run.
    c. Reports shall be viewed on the screen when the report is run and the data has been compiled.
33. Custom Report Generation:

a. The software shall contain a built-in custom report generator, featuring word processing and Visual Basic tools for the creation of custom reports.
b. The custom reports shall be setup to automatically run or be generated on demand.
c. Workstations shall display reports in Adobe (.PDF) format.
d. Reports can be of any length and contain any attributes from any controller on the network.
e. The report generator shall have access to the user programming language to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.
f. It shall be possible to run other executable programs whenever a report is initiated.
g. Report Generator activity shall be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
h. The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system.
i. The reports shall be user-configurable and able to extract live (controller) data and/or data from the database.
j. The user shall be able to setup each report to display in any text font, color and background color.
k. Reports shall be able to be configured to filter data, sort data and highlight data which meets user-defined criteria.
l. HTML Reporting - Spreadsheet-style reports shall be able to be run to an HTML template file. This feature creates an HTML “results” file in the directory of the HTML template. This directory is shared with other computer users, which allow those users with access to the directory to “point” their web browser at the file and view the report.
m. Access privileges shall be provided to allow the user the privilege of creating, deleting, updating, saving, processing, viewing and printing reports.
n. The reports shall be able to be printed on a printer, or exported to an electronic file.
o. Once a report is developed and saved, the user shall have the option to permanently incorporate the report into the system's application by compiling the report definition into a report list available to any system Workstation.
p. The database report configuration is an option available for any Workstation.

34. System DVD Backup
    a. The SMS shall provide DVD backup and restore programs utilizing the multi-tasking capabilities of the SMS system which run concurrent with any other application of the system and in no way, inhibit other use of the terminal.
    b. Database backup shall occur dynamically while other alarm monitoring, Photo Imaging, access control applications remain active.

c. The number of active events to be stored is user-definable. If the event log is filled to capacity before an archive backup is done, the system starts to overwrite the oldest events to make room for the newer events.
d. The following functions are provided for the backup procedure of the system application:
    1) Archive Information - This function shall indicate how many days of event history is to be maintained on the system.
    2) Warnings - The SMS shall provide a configurable warning to allow a System Administrator to enable and define automatic system warnings. These warnings are sent to all currently active Alarm Monitoring workstations to notify the users when the event log is starting to get full.
    3) Capacity - The event queue storage capacity is displayed as a number up to 8 digits long that specifies the number of event records that can be stored on the system. This number is determined by the size of the fixed disk drive installed and is generated by the system's database.

35. Color Graphic Map Configuration:
    a. The system shall have the capability to draw, edit and copy site color graphic maps using any third-party system software.
    b. The map configuration software shall import map drawings from JPEG (.JPG) and Bitmap (.BMP) and AutoCAD (.DWG) file formats as a minimum.
    c. Architectural-type maps shall allow the detailed layout of an entire structure, part of a structure, a floor or department within a building, or layout the periphery of a facility.
    d. Overview maps of an entire facility or campus shall be viewable as requested, or a specific entry point of a facility can be accessed via graphic panel objects that shall be able to be configured with multiple “tabbed” pages allowing a user to quickly view individual graphics of equipment, which make up a subsystem or system.
    e. Once a map has been drawn, the user shall have the capability to place system level icons of card readers and input points in the appropriate area to indicate their respective location on the map. This is to be accomplished by simply dragging the icon with the mouse to the appropriate location on the map.
    f. The SMS shall permit use of OCXs, and a full library of these controls including knobs, dials, gauges, switches, peripheral devices such as lights, motion detectors, doors, etc., shall be provided as part of the SMS software.
    g. The CONTRACTOR shall provide various maps to be associated with each area and create a hierarchy of maps for the site.
    h. The SMS shall support graphic maps having a resolution of 1024x768 pixels.
36. Remote System Support:
    a. The SMS shall include remote system support from the system manufacturer and/or local support dealer with remote diagnostics equipment that is included in at least one system Workstation.

b. The SMS shall support the capability to allow a remote technical assistance center analyze and perform any system diagnostic function using a modem and remote communications software, in support of personnel troubleshooting and correct problems via a standard dial-up phone line or internet over a DSL modem.
c. At a minimum, a 56K baud modem shall be provided for a serial port at a system Workstation on the SMS as required for the project.

37. SMS Data Exchange:
    a. Data Import/Export - The SMS shall provide a function that shall allow the end user, and/or CONTRACTOR, to create import and/or export scripts to/from the SMS.
    b. Inherent to this utility is an automated import process, including “insert record,” “update record,” “update/insert record,” and “delete record” (i.e. the assignment of access privileges).
    c. This utility shall allow the export of SMS System records into OWNER defined formats for use in external applications and systems.
    d. This utility shall allow the user to specify options, including files, fields, delimiters and/or fixed field lengths, formats, import/export mode, rules, and criteria.
    e. The user shall be able to indicate where the import or export file shall be located; on hard disk drive or removable media (i.e. external hard drive, memory stick, etc).
    f. Once these ASCII-based files are received, the SMS shall automatically import these records into the database without requiring user interaction.
    g. An application program within the SMS shall continuously query any shared resource on the network to which the HR generated file is to be written; and once a file is detected, the program shall initiate the reload of this file into the database using OLE servers at a user workstation.
    h. Records shall be capable of being added, deleted, and modified from the SMS database using this procedure.
    i. The SMS shall delete the file written to the shared resource immediately upon its import into the database.
38. Distributed Intelligence:
    a. In the event system communications is lost or the file server fails, all network and site controllers shall be configured to provide complete control, operation and supervision of all monitoring and control points.
    b. Upon failure of both servers (or the communications paths to those servers) the SMS shall be configured to allow any workstation in the network the ability to communicate directly to any network/site controller at the facility, and provide complete control, operation, and supervision of all alarm monitoring and control points from that workstation.
    c. The network/site controllers shall be configured with a UPS battery which shall support the controllers for a minimum of 4 hours.
    d. The network/site controllers shall be installed with enough memory to support 78,000 cardholders.
    e. The SMS shall incorporate performance tests and precautions to avoid system failure.

f. In the event of a failure, transactions are to be stored in a buffer until the field controller comes back on-line, at which time all data is uploaded to a Workstation for reporting and delivery to the file server.
g. The network/site controllers shall register as on-line with the Workstations when communications are re-established.
h. A complete download of database and access information shall not be required because of off-line operation.

39. Other:
    a. The site SMS components shall be configured to allow all security information (Access, Intrusion, IPCAM alarms, images, and events) to be transmitted over a TCP/IP network to the remote monitoring stations.
    b. All security system software and hardware provided by the CONTRACTOR shall be scalable.

C. ACS Functional Requirements:
1. Primary Function: The ACS primary function shall be to regulate access through specific doors and gates to secured areas of the facility. The ACS shall utilize a single database which is integrated to the existing databases previously established under prior OWNER projects. The CONTRACTOR shall integrate the facility's security improvement components into the existing databases, using standard naming conventions that provide a common database configuration management operating environment with previously established field defined conventions under prior OWNER projects.
2. All on site ACS network/site controllers shall be connected via high-speed IEEE 802.3 Ethernet LAN (within the site) and the WAN (to remote system components) running TCP/IP protocol.
3. All data shall reside on a single database (enterprise wide) and the data stored within this database shall be instantly accessible by every Workstation (on site and off site) connected to the network. Each onsite ACS network/site controller shall maintain a database in real time, such that the failure of the network (local or remote) at any time shall not impact the functioning of the site security systems.
4. The ACS network controllers shall support multiple communication ports from which up to 32 I/O modules may be accessed.
5. The CONTRACTOR shall configure the Alarm Monitoring and Display Workstations to monitor all site security devices, such as card readers, controllers, and I/O modules.
6. The CONTRACTOR shall perform administrative configuration tasks such as assigning areas/zones with the site, developing schedules for the site, report generation for security events, displaying color graphic maps, etc, as necessary to fully integrate and configure the site into the overall enterprise wide SMS.
7. The CONTRACTOR shall configure the system database to contain all point configurations and programs in each of the ACS controllers that have been assigned to the network.
8. The ACS shall be integrated and configured to perform a wide variety of features and functions. These system functions are categorized into two (2) primary "system departments" which include:

a. Access Control: The ACS's primary purpose shall be to provide access control. The system shall be able to make access granted or denied decisions, authenticate access privileges, and to set schedules and holiday groups. All inputs and outputs shall be configured to be transmitted globally across the enterprise wide SMS network. Using application programming, these inputs and outputs shall be linked at all field controllers for purposes of implementing system-wide control strategies. The system shall support features such as area control, anti-passback, dial-up field hardware communications, extended shunt time, multiple-man rule, mustering, and area loading.

b. Alarm Management: The CONTRACTOR shall provide and import customized color graphic maps of the facility and attach alarm icons to these maps. Initial maps and associated alarm icons for all facilities and system devices shall be created and entered into the system by the CONTRACTOR. Alarms are to be assigned priority levels. A status window shall be configured to provide information about the specific alarm including date, time and location of the alarm. The ACS shall be configured with unique emergency instructions to be specified for each type of alarm. Output control operations shall be configured to lock, unlock or pulse control points, or groups of points. The ACS components shall be properly integrated/configured into the following existing enterprise wide SMS functions:
   1) Cardholder call-up function that provides a quick search and display of images in the database.
   2) A trace function that is available for users to locate and track activity on specific cardholders or card readers.
   3) An image comparison feature for use in conjunction with a IPCAM/VMS technology interface.
   4) System data back-up and remote diagnostic functions.

2.2 SMS WORKSTATION REQUIREMENTS (When Required)

A. The SMS workstation shall also fully integrate the IDS and IPCAM/VMS functionality for operator interfacing for monitoring and control of all integrated systems specified herein. All application software that is specified to be provided with these systems shall reside on the SMS workstation. It is the intent to provide an integration level between systems that shall provide the system operators with a seamless GUI presentation of all integrated systems for day to day monitoring and control. Operation of the individual sub-systems, within the overall system, shall require the operator to administrate the IDS and VMS from their individual native applications that reside on the SMS workstation.

B. The existing enterprise wide SMS is configured as a multi-workstation system where the database is located on a central file server. This central file server has been provided as part of another project. The client software on multi-workstation system shall access the file server database program via an Ethernet TCP/IP network.

C. System administration operations shall be available from any Workstation on the system. System Administrator functions include the creation of City of Phoenix specific facility map configurations, alarm response instructions, access privileges, schedules, holidays, field hardware groups, arm-disarm groups, area control, output groups, application programs and all required system configurations.

D. The SMS workstation shall be configured to perform alarm monitoring operations. The following major Alarm Monitoring tasks shall be included: graphical alarm monitoring, acknowledging alarms, performing traces, output control functions, and badge record lookup. In addition, the Alarm Monitoring Workstation shall also be utilized as an administration workstation as required.

E. Alarm monitoring and display workstation when required, shall be required and located in the Main Gate Guardhouse.

2.3 SMS WORKSTATION COMPUTER HARDWARE (WHEN REQUIRED)

A. Unless otherwise stated, computer equipment needed for each workstation consists of the following minimum requirement:
1. Intel Core i7-8700T (6 Cores/12MB/12T/up to 4.0GHz/35W
2. 64GB (4x16GB) 2666MHz DDR4 Memory
3. Gigabit Ethernet Controller
4. 500GB 5400rpm SATA Solid State Hybrid Drive w/8GB Flash
5. NVIDIA GeForce GT 730, 2GB
6. CD/DVD/USB drive
7. Four (4) - 24” Widescreen Flat Panel Monitors
8. Windows 10
9. Serial port and parallel port, 4 USB ports
10. Optical mouse
11. Full function keyboard
12. Audio sound card and speakers
13. License agreement for all applicable software.
14. Miscellaneous items for inclusion:
    a. Laser Printer - The laser printer shall include a parallel and direct Ethernet capable interface, dry-type laser electrophotographic process printer, minimum 8 ppm speed.
    b. Inkjet Printer - The event/report printer shall be an Inkjet printer which will print text data in draft and NLQ modes. The printer shall be capable of 9600 bauds, 18 CPI and less that 55db in quiet mode. Printer shall notify the user when paper supply has been depleted.
    c. Uninterruptible Power Supply capable of supplying fifteen (15) minutes of backup time to the workstation.

2.4 SMS FIELD HARDWARE DEVICES GENERAL REQUIREMENTS (WHEN REQUIRED)

A. The SMS shall be equipped with the field hardware required to receive alarms, administer all access granted/denied decisions, provide direct intelligent software

interface capability via RS-232 to third-party systems, and implement global operation strategies. Depending upon the configuration, the SMS field hardware shall be able to include any or all the following features:

1. Real Time Clock (RTC) - A battery backed RTC shall provide the following information: time-of-day, day, month, year, and day-of-week. In normal operation the system clock shall be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years. The system shall provide means to synchronize the time between all controllers and workstations on the network via centralized clock system provided by the City of Phoenix, Water Services Department.
2. Automatic Restart after Power Failure Upon Restoration of Power - All controllers shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
3. Approval Listings - As a minimum, all controllers shall be listed to comply with UL Standards 294 and 1076, and FCC.
4. Indicator Lamps - As a minimum, all controllers shall have LED indication of Power Status, CPU/Activity status, Communications status and Error status.
5. Packaging - The Primary Network Controller and I/O modules shall be cased in a sleek, lightweight plastic housing. Built-in quick-release fasteners at the back of the module shall be provided for DIN rail mounting. These fasteners shall also permit panel mounting in a NEMA-1,2,3,4/NEMA 4X style enclosure. The mechanical design shall incorporate built-in cable management troughs for wiring runs.

2.5 NETWORK CONTROLLERS (WHEN REQUIRED)

A. The Network Controllers (NET) shall provide overall system coordination, accept control programs, perform automated control functions and security management and perform all necessary mathematical functions.

B. All NET controllers shall permit multi-user operation from workstations and laptop service tools connected either locally or globally.

C. All NET controllers shall be provided with both RJ45 copper based ports and Multimode fiber based ports that support IEEE 802.11 Ethernet Standards at 10 Mbps or greater.

D. The NET controller shall be a native TCP/IP device and shall not require use of terminal servers or other devices to allow direct Ethernet connectivity. Use of PCs that serve as Ethernet gateways to the field controllers shall not be acceptable.

E. The interface link to other security systems shall take place at the NET controller and not at a central computer, so that in the event of failure of the controller the rest of the system shall continue to function correctly.

F. The interface links shall be provided to other systems as necessary such as fire detection, intrusion alarming, public address, and vehicle management, with the NET controller mounted adjacent to these systems' central processing units.

G. The system protocols shall be transferred via embedded programmed communications drivers or the SMS application software programming, which shall be resident within the NET controller.

H. This interface shall provide bi-directional communications between the SMS and the other systems so that complete integrated control and monitoring could be performed for all systems.

I. All NET controllers shall be microprocessor-based, multi-tasking, multi-user, and use real-time, digital control processors.

J. All NET controllers shall be provided with control panels that consist of modular hardware including power supply, CPU board, and input/output modules.

K. NET devices provided for telephone dial-up sites shall be interchangeable (same make and model) as the NET devices provided for Ethernet based sites.

L. All NET controllers on the Ethernet TCP/IP LAN/WAN shall be capable, out-of-the box, to be set up as a Web Server.

M. All NET controllers shall have the capability to store HTML code and “serve” pages to a browser.
   1. Any computer on the network running any operating system capable of running a standard Internet browser shall allow the user to access real-time data from the NET controllers via a standard Internet browser (Internet Explorer/Firefox) utilizing a TCP/IP Ethernet connection.
   2. The WEB interface shall be capable of password security, including validation of the requesting PC’s IP address.
   3. The WEB interface shall allow the sharing of data or information between any controller, or process or network interface (BACnet, LON and TCP/IP) that the SMS has knowledge of, regardless of where the point is connected on the SMS network or where it is acquired from.

N. All NET controllers shall be equipped with an application programming environment to allow users to create custom applications.
   1. All application programs are to be developed using an easy-to-use plain English oriented programming language inclusive of a complete set of Boolean logical expressions.
   2. Use of high level programming languages such as C or C++, or system manufacturer defined “canned” application programs will not be permitted. Application programs shall be used to enhance the functionality of the SMS by permitting custom control strategies and third-party user interfaces to be implemented.
   3. All programs shall be self-documenting by allowing the users to place comments anywhere within the body of the program.
   4. All global data shall be capable of being referenced at any NET or I/O Module and used in application specific programs to control an output, or multiple outputs at that controller.

5. Use of simple matrices to allow linking of inputs to outputs to meet this intent is not acceptable.

O. All NET controllers shall be equipped with the following:
   1. A minimum of 8MB of RAM with math coprocessor
   2. A minimum of 4MB of 'Flash EEPROM' memory for the system firmware.
   3. Firmware shall be updated on-line or over a standard dial-up modem connection.
   4. Use of EPROM-based firmware requiring chip change-out to perform upgrades is not acceptable.

P. All NET controllers shall provide a powerful multi-user solution for network communications and information management across a high-speed Ethernet based network at 10/100/1000 Mbps.

Q. Backbone based controllers shall provide communications to both the high-speed Ethernet LAN and a LON communications field bus. The LON communications bus shall support a family of application oriented I/O modules. The I/O bus shall permit LON communications using RS-485 or FTT-10. For Ethernet based Controllers, connections shall be provided with 10/100Base-T, if available at the time of purchase. If 10/100Base-T is not available at the time of purchase, then a 10Base-T interface shall be provided.

R. All NET controllers shall have built-in network communications error checking to the International Standard CRC16.

S. All NET controllers shall be provided with 4 programmable RS-232 ports for printers, modems, terminals, and third-party software interfaces.

T. All NET controllers shall be able to exchange information with other NETs over the LAN. The network structure shall be transparent such that each controller may store and reference all global variables available in the network for use in the NETs calculations or programs.

U. Each NET controller shall have access to any of the readers, inputs, outputs, and calculated variables contained in I/O modules that are connected to it through its local field bus.

V. All NET controllers shall operate from 100 to 240 VAC 50/60 Hz power. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning.

W. Battery Back-up - The NET controllers shall be provided with battery backup UPS circuit with batteries and built-in battery charger that provides automatic battery backup UPS power in event of AC line failure. Each NET shall provide programmable battery back-up controls which include a choice of shutdown options. Each network and site controllers shall be provided with sufficient battery capacity to support 72 hours of battery backup to maintain all volatile memory

and real-time clock, and rechargeable UPS battery backup for full systems operation for a minimum of four (4) hours.

X. All NET controllers shall be capable of Simple Network Management Protocol communications

2.6 SITE CONTROLLER (WHEN REQUIRED)

A. All Site Controller (SNET) shall provide intelligent, stand-alone or networked electronic access control and alarm monitoring control of a facility. They shall contain their own internal RAM memory and continue to operate all local control functions even in the event of a Network Server failure. In addition, the SNET's shall be able to communicate to other controllers on its Field Bus even in the event of Network Server failure. The SNET's shall maintain data integrity during a power failure through UPS or battery backed RAM.

B. The SNET shall include:
   1. Integrated testing and diagnostics for self-testing.
   2. Suitable interfaces and appropriate universal inputs and outputs to allow the connection of mechanical or electrical signals.
   3. Manual override facilities on all universal outputs for testing and commissioning purposes.
   4. Unique software address point on the network that does not require the manual setting of DIP or DIL switches.
   5. The provision of a service port facility to permit local access to be established as well as global networking data interrogation facilities.

C. The SNET shall incorporate card reader inputs and two lock outputs for door control; as well as, the ability to monitor up to four supervised alarm contacts and four universal alarm inputs. There shall be two digital outputs available for further functionality. The SNET shall provide power for locks, readers, and other peripheral equipment.

D. The card reader inputs shall be capable of reading Wiegand Proximity readers or ABA magstripe readers, and shall allow the use of keypads integral to those readers. The SNET shall include inputs for door switch and Request to Exit, as well as a door strike relay output.

E. The SNET shall be expandable with the addition of further controllers. The SNET shall be monitored through the SMS operator workstations.

F. The SNET shall incorporate on board Ethernet 10/100/1000 base-T interface, using native TCP/IP protocol to communicate to workstations. The SNET shall have on board SNMP management. If no high-speed network is available, the SNET shall support standard auto-dial modem connectivity. The network structure shall be transparent such that each SNET may store and reference any global variables available in the network for use in the local controller's calculations or programs.

G. The SNET shall feature flash memory eliminating the requirement for field EPROM changes.

H. The four universal inputs shall be capable of monitoring analog, digital, or supervised signals.

I. Each SNET shall manage its own personnel records, alarm and event buffering, history logging, and control sequences. On loss of communication to the Head End, the SNET shall buffer all alarms and events, and upload on restoration of communications.

J. The SNET shall incorporate battery back up. If power is lost, this back up shall support full operation for four hours.

2.7 I/O MODULES (WHEN REQUIRED)

A. I/O Modules – I/O modules shall be provided in a distributed or centrally located fashion. The I/O modules shall contain their own internal ROM, EEPROM, and SRAM. The I/O Modules shall maintain data integrity and full operation during a power failure through UPS or battery backed RAM.

B. Local I/O modules shall have the following:

1. Integrated testing and diagnostics for self-testing.
2. Suitable interfaces and appropriate universal inputs and outputs to allow the connection of mechanical or electrical signals.
3. Manual override facilities on all universal outputs for testing and commissioning purposes.
4. Unique software address point on the network that does not require the manual setting of DIP or DIL switches.

C. The I/O Modules shall cover the following range of types:
1. Access Control
2. Intrusion Detection and Digital Control
3. Voice Annunciation
4. Video Switching

D. All modules shall be able to exchange information between other I/O Modules and NET Controllers during each field bus scan. This peer-to-peer capability shall permit full entry/egress operation across any controllers on the network.

E. Indicator Lamps – As a minimum, all I/O modules shall have LED indication of Power Status, CPU/Activity status, Communications status and Error status.

F. Packaging – I/O modules shall be cased in a sleek, lightweight plastic housing. Built-in quick-release fasteners at the back of the module shall be provided for DIN rail mounting. These fasteners shall also permit panel mounting in a NEMA-1,2,3,4/NEMA 4X style enclosure. The mechanical design shall incorporate built-

in cable management troughs for wiring runs. The enclosure shall include a ruggedized key lock to prevent unauthorized access, and be rated for outdoor use if mounted outside. Manual override facilities on all outputs shall be provided for testing and commissioning purposes.

2.8 ACCESS CONTROL MODULE (WHEN REQUIRED)

A. The access control modules shall provide the interface for one card reader/keypad controlled door, and the NET Controller. Each access controller shall include a Wiegand or ABA style card reader input; at least three supervised inputs for door status, exit request, and other inputs; and at least two relay outputs for the door lock and an optional auxiliary controlled point.

B. Each access control module shall have the intelligence to perform all degrade-mode access control strategies stored in the access control modules non-volatile EEPROM, without communication to other modules, in the event of a communications loss to the NET Controller.

C. Each access control module shall complete its internal scan in less than one second. Each scan shall consist of updating of readers and keypads, supervised inputs, importing of data from other controllers, performing mathematical calculations and sequencing appropriate outputs for local control of doors, elevators, and other related devices. The maximum time for door opening from the proper presentation of a card shall be less than 1 second.

D. The access control module shall be fed from a low voltage, 24 VDC power supply with battery backup for a minimum of four (4) hours.

E. Inputs - The input section of the access control modules shall provide a minimum of 1 card reader channel and 1 keypad channel. It shall be possible to expand the number of card readers by simply adding access control modules to the NET controller. In addition, there shall be 3 supervised inputs on the base controller for request-to-exit devices, door status devices, and general supervised input monitoring.
   1. The card reader inputs shall accept Wiegand or Magnetic Stripe style readers. Up to 64 bits per card formats shall be supported for Wiegand applications and up to 255 bits per card formats shall be supported in ABA applications.
   2. Each supervised input shall be able to distinguish among normal operation, a short, open circuit, or a fault. Inputs shall be able to use double resistor-based supervised circuits.
   3. A normally open momentary switch shall be used for external tamper detection. This switch shall detect whenever the cabinet of the access control module has been opened.
   4. The access control module shall support Wiegand output or ABA output keypads. The keypad data shall be superimposed onto the Wiegand or ABA data lines.

F. Outputs - Output types shall be digital for control of doors. In addition to the door output, the control module shall contain one auxiliary output for ON/OFF control of annunciators, lights, etc. Outputs shall be available with built-in override switches.
   1. The digital outputs shall be rated for 24 VAC/DC operation at 5 amps minimum. Each output shall have a corresponding LED for visual indication of its state.
   2. A board-mounted 3-position switch shall be provided for each output allowing local overrides. The position of the switch shall be detectable in software and available for alarm annunciation. If override switches are not provided on board, external switches shall be provided and wired to include feedback and alarming of the switch position, and shall be mounted in a locked enclosure.

2.9 PROXIMITY CARD READERS (WHEN REQUIRED)

A. COP requires the SMS to provide HID Indala Triple Technology readers per current COP standard. The reader needs to be programmed with the COP current protocol. Each reader shall offer a low profile, rugged, weatherized polycarbonate sealed enclosure with multi-color LED's and an audio function for access granted and denied indications. Each shall be mountable indoor or outdoor.

2.10 FIELD HARDWARE POWER SUPPLIES (WHEN REQUIRED)

A. Power Supplies for field hardware shall be compatible with the SMS equipment installed. Power supplies shall be regulated, linear and isolated versions for the field controllers and other equipment and shall be UL listed for specific application. Each version shall be available in UPS with battery back-up models only. All power supplies shall be housed in tampered, locked enclosures.

2.11 DOOR HARDWARE AND SWITCHES (WHEN REQUIRED)

A. Ancillary door hardware shall meet the following minimum specifications:
   1. A surface mounted magnetic switch shall be used for roof hatch alarms.
   2. A wide gap overhead door contact shall be used for overhead loading dock doors. A low profile rugged aluminum housing shall mount directly to the floor. Connection to the alarm circuit junction box shall be armored cable to protect the wiring. The magnet shall also be protected by a rugged aluminum housing mounted on the bottom of the overhead door. Both the switch and the magnet assembly shall be weatherproofed and resistant to shock with multiple layers of protection.
   3. All exterior doors without electric door strikes shall be provided with a latch position indicating switch (monitor strike) which shall be internal to the door and concealed from view.
   4. An electro-mechanical lockset shall be used for specific doors, with an access control CR. The strikes shall operate on 24 VDC signal. A double signal switch shall be provided for indicating the status condition of the latch

when not energized, and to activate a local alarm. The types of electric door latch shall be as follows:

a. Fail secure: At the loss of electric energy, these locks doors shall lock. At restoration of electrical energy, these locks doors shall automatically return to open default configuration.
b. Fail safe: At the loss of electric energy, these locks doors shall open unlock. At the restoration of electric energy, the locks doors shall automatically lock return to default configuration.

5. The local alarm buzzer shall be provided by the CONTRACTOR for all doors with panic hardware and other specific doors, as noted on the Contract Drawings. The buzzer shall operate on a 24 VDC signal and shall be at least 10dBA above ambient noise. It shall be flush mounted on the secured side of the door. Its appearance shall be unobtrusive to its immediate surroundings.

B. Magnetic door switches, door strikes, door strike indicators, panic hardware, door closures, etc., to complete the system. CONTRACTOR shall be responsible for providing all necessary hardware, and for the complete operation of all related hardware.

C. Input Power Requirements:
1. Major components of the door locking system, such as electronic locks, shall operate on 120 VAC, 60 Hz, single phase input power. Monitoring alarm devices and access control devices, such as door strikes, latches, etc., shall be powered by 24 VDC (2 wire-ungrounded), class 1 power limited circuits. Appropriate sized transformer(s), rectifier(s) or power supplies shall be provided for monitoring alarm devices by the CONTRACTOR, which shall receive its electricity from the building. Appropriate power supplies shall be provided for access control devices which shall receive their electricity from the building.

D. Spare Parts - A recommended spare parts list shall be provided, including part price and quantity of each item and for the lot. Where appropriate, spare parts shall be quoted as sub-system modular replacements.

E. Door Types:
1. Door types for the Project have been grouped as follows:

TYPE	CONFIGURATION	STRIKE TYPE	EXIT CONTROL	OPERATION	LOCAL ALARM
A	Double	Lockset	REX in lockset	Fail-Closed	No
B	Single	Lockset	REX in lockset	Fail-Closed	No
C	Double	Crashbar	Microswitch	Fail Closed	No
D	Single	Strike	PIR/REX switch	Fail Closed	No

2. Secured door type “A and C” (Double doors to the facility):
a. Opening either door of secured door type “A” or “C” shall cause a change in state of the magnetic switch (MS) or the monitor strike (MST)

and an alarm condition shall be generated by the SMS. Only one device shall be required to generate an alarm condition.

b. Entry through a secured door type “A” or “C” shall require the use of an authorized access card. The access card shall be presented to the CR and the SMS shall verify that the individual is authorized for the specific access point at that specific time of day and day of the week. If the individual is authorized the SMS shall grant access by momentarily energizing the electro-mechanical lockset or energizing the latch retraction solenoid and shunting the alarm condition that shall be generated by the MS and MST when the door is opened. The alarm condition shunt shall only be effective for a maximum of 30 seconds to prevent the door from being propped open after a valid access. If the door remains open 30 seconds after a valid access the SMS shall generate a “Held Open” alarm condition and display this alarm on the workstation.

c. Exit through a secured door type “A” shall be similar to the entry procedure, except that a Request-to-Exit (REX) device shall be used in place of the CR. In an emergency, the exit shall Fail-Open, but shall cause the SMS to generate an alarm condition.

d. Exit through a secured door type “C” shall be similar to the entry procedure, except that the change of state of a Crash-bar mounted micro-switch shall be used in place of the CR. In an emergency, the exit shall Fail-Close.

3. Secured door type “B” and “D” (Single door to the facility):

a. Opening the door of secured door type “B” or “D” shall cause a change in state of the magnetic switch (MS) or the monitor strike (MST) and an alarm condition shall be generated by the SMS.

b. Entry through a secured door type “B” or “D” shall require the use of an authorized access card. The access card shall be presented to the CR and the SMS shall verify that the individual is authorized for the specific access point at that specific time of day and day of the week. If the individual is authorized the SMS shall grant access by momentarily energizing the electro-mechanical lockset or energizing the latch retraction solenoid and shunting the alarm condition that shall be generated by the MS and MST when the door is opened. The alarm condition shunt shall only be effective for a maximum of 30 seconds to prevent the door from being propped open after a valid access. If the door remains open 30 seconds after a valid access the SMS shall generate a “Held Open” alarm condition and display this alarm on the workstation.

c. Exit through a secured door type “B” or “D” shall be similar to the entry procedure, except that a REX device shall be used in place of the CR. In an emergency, the exit shall Fail-Close.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the SMS shall include the appropriate equipment and shall be performed by a pre-qualified security integrator. The installation shall be completed to these specifications and project plans as required by the OWNER. A comprehensive OWNER site-planning guide for the SMS shall be provided. Adherence to the specific requirements of this document will assist in ensuring a successful system installation. The installation shall include the following:
   1. Site planning and system configuration of field hardware and SMS. CONTRACTOR shall consult with the OWNER for required camera pre-sets, access level configuration, and other systems programming.
   2. Complete system setup at the Head End.
   3. Setup of specific network software configuration requirements.
   4. Complete system diagnostics verification.
   5. Complete system operation verification.
   6. Problem reporting and tracking.
   7. Project specific installation log.
   8. Completion of specific OWNER acceptance test plans.
   9. Formal turnover of the specific project installation documentation to OWNER.

3.2 FIELD QUALITY ASSURANCE

A. Performance Specification Requirements: Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated.

B. General overall performance of a product is implied where the product is specified for a specific application. All equipment shall be installed per applicable UL listing for that device or component.

C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

3.3 ACCEPTANCE TESTING

A. Acceptance testing shall be per Section 28 08 10, Integrated Security Management System – Start-up, Commissioning and Field Testing.

B. The CONTRACTOR shall test all system requirements to ensure proper operation and configuration of the SMS. These requirements shall apply to all integrated system components and software, including, but not limited to all system computers, field controllers, card reader devices, IP Cameras and equipment and interface capability.

C. The CONTRACTOR shall develop operational scenarios to simulate the actual use of the system in the normal environment of the facility, as part of the acceptance testing. The OWNER reserves the right to modify the

CONTRACTOR'S test plan or require the CONTRACTOR to add additional operational test procedures to effectively exercise all system operations.

3.4 SYSTEM TRAINING

A. The CONTRACTOR shall provide training in accordance with Section 28 08 13, Integrated Security Management System – Training.

+ + END OF SECTION + +

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SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to perform all clearing and grubbing as shown on the Drawings and specified.

B. The Work covered by this Section consists of removing and disposing of all trees, stumps, bush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material from the site, as required to perform the Work.

1.2 QUALITY ASSURANCE

A. Codes and Standards: State and local laws and code requirements shall govern the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter.

1.3 JOB CONDITIONS

A. Protection:
   1. Streets, roads, adjacent property and other works and structures shall be protected throughout the entire Project. Return to original condition, satisfactory to the ENGINEER, damaged facilities caused by CONTRACTOR'S operations.
   2. Trees, shrubs, grassed and landscaped areas, which are to remain, shall be protected by fences, barricades, wrapping or other methods as shown on the Drawings, specified or approved by the ENGINEER. Equipment, stockpiles, etc. shall not be permitted within tree branch spread. Trees shall not be removed without approval of the ENGINEER, unless shown or specified.

B. Salvable Improvements:
   1. Unless specified elsewhere, carefully remove items to be salvaged and store on premises in approved location, all in accordance with recommendations of specialists recognized in the Work involved.

1.4 GUARANTEE

A. Guarantee that Work performed under this Section will not permanently damage trees, shrubs, turf or plants designated to remain, or other adjacent work or facilities. If damage resulting from CONTRACTOR'S operations appears during the period up to 18 months after completion of the Project, replace damaged items, at no additional cost to OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. Limits of clearing shall be all areas within the Contract limit lines, except as otherwise shown on the Drawings. Damage outside these limits caused by CONTRACTOR'S operations shall be corrected at CONTRACTOR'S expense.

B. Remove from the site and satisfactorily dispose of all trees, shrubs, stumps, roots, brush, masonry, rubbish, scrap, debris, pavement, curbs, fences and miscellaneous other structures not covered under other Sections as shown on the Drawings, specified or otherwise required to permit construction of the Work. Comply with requirements of Section 02 41 00, Demolitions.

C. No cleared or grubbed material may be used in backfills or structural embankments. Comply with requirements of Section 31 23 00, Structural Excavation and Backfill.

D. Burning on the site will not be allowed.

E. In order to avoid additional removal or damage, existing trees and shrubs shall be trimmed as required. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty who are approved by ENGINEER. Trees and shrubs intended to remain, which are damaged beyond repair or removed, shall be replaced by CONTRACTOR at no additional cost to OWNER.

F. Control air pollution caused by dust and dirt and complies with governing regulations.

3.2 TOPSOIL REMOVAL

A. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4- inches. Topsoil shall be substantially free of subsoil, clay lumps, stones, and other objects over 2-inches in diameter, and without weeds, roots, and other objectionable material.

B. Strip topsoil which is satisfactory to whatever depths are encountered, and in such manner as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
   1. Where trees are shown on the Drawings or directed by the ENGINEER to be left standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system.

C. Stockpile topsoil in storage piles in areas shown on the Drawings, or where otherwise approved by ENGINEER. Construct storage piles to freely drain surface water. Cover storage piles, if required, to prevent windblown dust. Topsoil in excess of quantity required shall remain property of OWNER.

D. Dispose of excess topsoil as waste material off site.

+ + END OF SECTION + +

SECTION 31 23 00

EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to perform all excavating, backfilling, filling and grading, and disposing of earth materials as shown on the Drawings, specified, and required for construction of retaining walls, manholes, vaults, structure foundations, underground ductbanks, electrical manholes and handholes, and other structures and facilities required to complete the Work in every respect.
   2. All necessary preparation of subgrade for slabs, foundations and pavements is included.
   3. All temporary means required to prevent discharge of sediment to water courses from dewatering systems or erosion are included.
   4. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof, except rock.
   4. On-site excavated material will be classified for use as backfill material. Excavation materials include all materials regardless of type, character, composition, moisture, or condition thereof.
   5. Perform all earthwork as specified in this Section.

B. General: (NOT USED).

1.2 QUALITY ASSURANCE

A. Testing Services:
   1. General: Testing of materials, testing for moisture content during placement and compaction of fill materials, and of compaction requirements for compliance with technical requirements of the Specifications shall be performed by a testing laboratory as designated in Section 01 45 29.15, Testing Laboratory Services Furnished by OWNER, and Section 01 45 29.20, Testing Laboratory Services Furnished by CONTRACTOR.
   2. OWNER'S Testing Agency Scope:
      a. Test CONTRACTOR'S proposed materials in the laboratory and/or field for compliance with the Specifications.
      b. Perform field moisture content and density tests to assure that the specified compaction of backfill materials has been obtained.
      c. Report all test results to the ENGINEER and CONTRACTOR.
   3. Authority and Duties of OWNER'S Testing Agency: Technicians representing the testing laboratory shall inspect the materials in the field and perform tests and shall report their findings to the ENGINEER and CONTRACTOR. When the materials furnished or Work performed fails to fulfill Specification

requirements, the technician will direct the attention of the ENGINEER and CONTRACTOR to such failure.

a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Contract Documents, nor to approve or accept any portion of the Work.

4. Responsibilities and Duties of CONTRACTOR:
   a. The use of testing services shall in no way relieve CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
   b. To facilitate testing services:
      1) Secure and deliver to the ENGINEER or to the testing agency, without cost, preliminary representative samples of the materials he proposes to use and which are required to be tested.
      2) Furnish such casual labor as is necessary to obtain and handle samples at the Work site or at other sources of material.
      3) Advise the OWNER'S testing agency at least two days in advance of any backfill operations to allow for completion of quality tests and for the assignment of personnel.
   c. CONTRACTOR'S Testing Service shall inspect and approve subgrades and fill layers before further construction Work is performed thereon.
   d. Responsibility belongs to CONTRACTOR to accomplish the specified compaction for backfill, fill, and other earthwork, and to control his operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.
   e. The frequency of CONTRACTOR'S confirmation tests shall be not less than as follows; each test location for trenches shall include tests for each layer, type, or class of backfill from bedding to finish grade.
      1) Trenches for structures, and underground ductbanks:
         a) In open fields: Two locations every 1,000 linear feet.
         b) Along dirt or gravel roads or off traveled right-of-way: Two locations every 500 linear feet.
         c) Crossing paved roads: Two locations along each crossing.
         d) Under pavement cuts or within two feet of pavement edges: One location every 400 linear feet.
      2) For structural backfill: On 30-foot intervals on all sides of the structure for every compacted lift but no less than one per lift on each side of the structure for structures less than 60 feet long on a side.
      3) In embankment or fill: One per 1000 square feet on every compacted lift.
      4) Base material: One per 1000 square feet on every compacted lift.
      5) Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.
      6) Paved Areas and Building Slab Subgrade: Make at least one field

density test of subgrade for every 500 square feet of paved area or building slab, but in no case less than three tests. In each compacted fill layer, make one field density test for every 1000 square feet of overlaying building slab or paved area, but in no case less than three tests.

7) Foundation Wall Backfill: Take at least two field density tests, at locations and elevations as directed by the ENGINEER.

f. Copies of the test reports shall be submitted promptly to the ENGINEER. CONTRACTOR'S tests to be performed by a soils testing laboratory acceptable to the ENGINEER.

g. Demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
   1) 200 linear feet of trench backfill.
   2) 10 cubic yards of structural backfill.
   3) 100 cubic yards of embankment work.
   4) 50 cubic yards of base material.

h. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.

i. Periodic compliance tests will be made by the ENGINEER to verify that compaction is conforming to the requirements previously specified, at no cost to CONTRACTOR. CONTRACTOR shall remove the overburden above the level at which the ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete.

j. If compaction fails to conform to the specified requirements, remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR'S confirmation tests to be performed in a manner acceptable to the ENGINEER. Frequency of confirmation tests for remedial Work shall be double that amount specified for initial confirmation tests.

B. Permits and Regulations:
   1. Obtain all necessary permits for Work in roads, rights-of-way, railroads, etc. Also, obtain permits as required by local, state and federal agencies for discharging water from excavations.
   2. Perform excavation Work in compliance with applicable requirements of governing authorities having jurisdiction.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 36, Specification for Structural Steel.
   2. ASTM A 328, Specification for Steel Sheet Piling.
   3. ASTM D 422, Method for Particle-Size Analysis of Soils.
   4. ASTM D 427, Test Methods for Shrinkage Factors of Soils by the Mercury Method.
   5. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil.
   6. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

7. ASTM D 2166, Test Method for Unconfined Compressive Strength Of Cohesive Soils.
8. ASTM D 2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D 4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
10. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
11. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .650 (Subpart P - Excavations).
12. Phoenix Building Code.
13. Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix, Section 206, Structure Excavation and Backfill, Section 604, Placement of Controlled Low Strength Material, Section 702, Base Materials, Section 725, Portland Cement Concrete, Section 728, Controlled Low Strength Material. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Excavation and Backfill Submittals:
      a. Excavation Plan: Prior to start of excavation operations, a written plan shall be submitted to demonstrate compliance with OSHA Standard 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
         1) Name of competent person.
         2) Excavation method(s) or protective system(s) to be used.
         3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
      b. Excavation and backfill requirements detailing sheeting and bracing, or other protective system(s), dewatering systems, cofferdams, and underpinning.
      c. Shop Drawings shall be prepared by a Registered Professional Engineer, licensed in the State of Arizona, recognized as an expert in the specialty involved. Drawings shall be submitted to ENGINEER for record purposes only. Calculations shall not be submitted. Drawing submittals will not be checked and will not imply approval by ENGINEER of the Work involved. Sole responsibility for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering belongs to CONTRACTOR.
      d. Samples of all materials, including select backfill, general backfill, crushed stone and sand shall be submitted to the ENGINEER and the testing service. Samples of the proposed material shall be submitted at least 14 days in advance of its anticipated use.
   2. Test Reports:
      a. Testing laboratory shall submit copies of the following reports directly to ENGINEER, with copy to CONTRACTOR:
         1) Tests on borrow material.

2) Tests on footing subgrade.
3) Field density tests.
4) Optimum moisture - maximum density curve for each soil used for backfill.
5) Tests of actual unconfined compressive strength or bearing tests of each strata.
6) Reports of observations for conformance of borrow material to the Project Geotechnical Report.

1.4 JOB CONDITIONS

A. Subsurface Information: The data is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. OWNER will not be responsible for interpretations or conclusions by CONTRACTOR. Data is solely made available for the convenience of CONTRACTOR.
   1. Additional test borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER.
   2. Refer to and comply with the requirements of Section 02 41 00, Demolitions.

B. Existing Structures: The Drawings show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown on the Drawings for the convenience of CONTRACTOR. Explore ahead of the required excavation to determine the exact location of all existing structures. Structures shall be supported and protected from damage by CONTRACTOR. If they are broken or damaged, restore them immediately, at no additional cost to the OWNER.

C. Existing Utilities: Locate existing underground utilities in the areas of the Work. If utilities are to remain in place, provide adequate means of protection during all operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult piping or utility owner and ENGINEER immediately for directions as to procedure. Cooperate with OWNER and utility owner in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
   2. In general, service lines to individual houses and businesses are not shown on the Drawings, however, assume that a service exists for each utility to each house or business.
   3. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.
   4. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. Use of Explosives:
   1. The use of explosives will not be permitted.
   2. Do not bring explosives onto site or use in the Work without prior written permission from authorities having jurisdiction. Provide copy of authorization to

ENGINEER. Sole responsibility for handling, storage, and use of explosive materials when their use is permitted belongs to CONTRACTOR.

E. Protection of Persons and Property: Barricade open excavations occurring as part of the Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

F. Dust Control: Conduct all operations meeting the requirements specified in Section 01 41 27, Earthmoving and Dust Control.

G. Roadways and Walks: Unless otherwise approved by ENGINEER, excavated material and materials of construction shall be so deposited, and the Work shall be so conducted, as to leave open and free for pedestrian traffic all crosswalks, and for vehicular traffic a roadway not less than ten feet in width. All hydrants, valves, fire alarm boxes, letter boxes, and other facilities which may require access during construction shall be kept accessible for use. During the progress of the Work, maintain such crosswalks, sidewalks, and roadways in satisfactory condition and the Work shall at all times be so conducted as to cause a minimum of inconvenience to public travel, and to permit safe and convenient access to private and public property along the line of the Work.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Backfill and Fill Materials:
   1. Materials acceptable for use as backfill against walls, foundations, underground ductbanks, and other structures shall be stockpiled native sandy clay or granular soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 4-inches in size, nor have greater than 40 percent passing the 200 sieve. The maximum expansion of on-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
   2. Backfill and fill materials from off-site sources shall consist of silty or clayey sand soils which are uniformly mixed, contain no organic matter and which have a Plasticity Index less than ten. The maximum particle size of imported soils shall be 4-inches or less, if required to satisfy trenching, landscaping, or other requirements. The maximum expansion of off-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
   3. All materials for use as backfill and fill material shall be tested by the laboratory and approved by the ENGINEER.
   4. If on-site material is unsuitable as determined by the ENGINEER, select backfill or approved off-site fill shall be used.

5. Fill adjacent to structures is classified as backfill to a distance measured horizontally from the structure that is equal to the depth from the finished grade. Outside these limits the fill is classified as embankments, unless otherwise specified.

B. Select Backfill: Select Backfill for use beneath concrete slabs and asphaltic pavements shall be crushed aggregate conforming to the requirements below:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1-1/4-inch	100
No. 4	38 to 65
No. 8	25 to 60
No. 30	10 to 40
No. 200	3 to 12

C. Fill Material for Embankments:
1. Fill materials for use as embankments, and as miscellaneous landscaping materials exterior to plant facilities, shall consist of soils obtained from on-site excavations or off-site sources that are uniformly mixed, contain no organic material, rocks or fragments greater than 3-inches in size.
2. All materials for use as described above shall be tested by the laboratory and approved by the ENGINEER.

D. Drainage Fill: Washed, uniformly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than five percent passing a No. 4 sieve. Crushed stone or gravel shall be crushed rock or gravel conforming to the requirements of Section 31 23 23.11, Crushed Stone and Gravel.

E. General Backfill and Fill Materials: Provide approved soil materials for backfill and fill, free of clay, rock or gravel larger than 6-inches in any dimension, debris, waste, frozen materials, vegetable and other organic matter and other deleterious materials. Previously excavated materials meeting these requirements may be used for backfill.

PART 3 -EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavating, filling, and grading are to be performed. The CONTRACTOR to call for a final inspection by the ENGINEER of all components to be buried and comply with the inspection recommendations. ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 SITE PREPARATION

A. Clear all areas to be occupied by permanent construction or embankments of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip subgrades for fills and embankments of vegetation, sod, topsoil and organic matter. All waste materials shall be removed from site and properly disposed of by CONTRACTOR. Burning is not be permitted. Refer to and comply with the requirements of Section 31 10 00, Site Clearing.

3.3 TEST PITS

A. General:
   1. Excavate and backfill, in advance of the construction, test pits to determine conditions or location of the existing utilities and structures. Perform all Work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, backfilling and replacing pavement for the test pits.
      a. Responsibility for the definite location of each existing facility involved within the area of his excavation for Work under this Contract belongs to CONTRACTOR. Care shall be exercised during such location work to avoid damaging and/or disrupting the affected facility. Responsibility for repairing, at his expense, damage to any structure, piping, or utility caused by his Work, belongs to CONTRACTOR.

B. No separate payment will be made for test pits shown on the Drawings.

C. Test pits ordered by ENGINEER are incidental to the project.

D. No separate payment will be made for test pits made by CONTRACTOR for his own use.

3.4 EXCAVATION

A. Perform all excavation required to complete the Work as shown on the Drawings, specified and required. Excavations shall include earth, sand, clay, gravel, hardpan, boulders not requiring drilling and blasting for removal, decomposed rock, pavements, rubbish and all other materials within the excavation limits, except rock.

B. Excavations for structures and underground ductbanks shall be open excavations. Provide excavation protection system(s) required by ordinances, codes, law and regulations to prevent injury to workmen and to prevent damage to new and existing structures or pipelines. Unless shown on the Drawings or specified otherwise, protection system(s) shall be utilized under the following conditions.
   1. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   2. Excavations More Than Five Feet Deep: Excavations in stable rock where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded or shored and braced.
   3. Excavation protection system(s) shall be installed and maintained in accordance with drawings submitted under Article 1.3, above.

C. Where the structure or ductbank is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of said structure under dry conditions. Dry conditions shall prevail until concrete has reached sufficient strength to withstand earth and hydrostatic loads. In addition, protect excavation from flooding until all walls and floor framing up to and including grade level floors are in place and backfilling has begun. Water level shall be maintained below top of backfill at all times.

D. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade.

E. The elevation of the bottom of footings shown on the Drawings shall be considered as approximate only and ENGINEER may order such changes in dimensions and elevations as may be required to secure a satisfactory footing. All structure excavations shall be hand-trimmed to permit the placing of full widths, and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted.

F. When excavations are made below the required grades, without the written order of ENGINEER, they shall be backfilled with select backfill material, as directed by ENGINEER, at the expense of CONTRACTOR.

G. Excavations shall be extended sufficiently on each side of structures, footings, etc., to permit setting of forms, installation of shoring or bracing or the safe sloping of banks.

H. Subgrades for roadways and structures shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades which are otherwise solid, but which become soft or mucky on top due to construction operations, shall be reinforced with select backfill material. The finished elevation of stabilized subgrades shall not be above subgrade elevations shown on the Drawings. Proof roll all subgrades prior to placing of select fill and general fill material.

I. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
   1. Locate and retain soil materials away from edge of excavations.
   2. Dispose of excess soil material and waste materials as specified hereinafter.
   3. Stockpiled excavated soils for use as subsequent fill shall be classified by laboratory as on-site granular or sandy clay soils. Use and placement of fill shall be performed as specified for each class.
   4. Excess soil from excavations shall be disposed of off-site. Disposal shall be in accordance with state and local regulatory requirements.

J. Where ENGINEER considers the existing material beneath the bedding material unsuitable, CONTRACTOR remove same and replace it with select backfill.

3.5 UNAUTHORIZED EXCAVATION

A. All excavation outside the lines and grades shown on the Drawings, and which is not approved by ENGINEER, together with the removal and disposal of the associated material shall be at CONTRACTOR'S expense. Unauthorized excavations shall be filled and compacted with select backfill by CONTRACTOR at his expense.

3.6 DRAINAGE, EROSION CONTROL AND DEWATERING

A. Erosion Control:
   1. In general, the construction procedures outlined herein shall be implemented to assure minimum damage to the environment during construction. Take any and all additional measures required to conform to the requirements of applicable codes and regulations, and the requirements specified in Section 01 57 23, Stormwater Pollution Prevention Plan and Permit.
   2. Whenever possible, access and temporary roads shall be located and constructed to avoid environmental damage. Provisions shall be made to regulate drainage, avoid erosion and minimize damage to vegetation.
   3. Where areas must be cleared for storage of materials or temporary structures, provisions shall be made for regulating drainage and controlling erosion, subject to the ENGINEER'S approval.
   4. Temporary measures shall be applied to control erosion and to minimize the silting of the existing waterways, and natural ponding areas. Such measures shall include, but are not limited to, the use of berms, baled straw silt barriers, gravel or crushed stone, mulch, slope drains and other methods. These temporary measures shall be applied to erodible materials exposed by any activities associated with the construction of this Work.
      a. Special care shall be taken to eliminate depressions that could serve as mosquito pools.
      b. Temporary measures shall be coordinated with the construction of permanent drainage facilities and other Work to the extent practicable to assure economical, effective, and continuous erosion and silt control.
      c. Provide special care in areas with steep slopes. Disturbance of vegetation shall be kept to a minimum to maintain stability.
   5. Remove only those shrubs and grasses that must be removed for construction. Protect the remainder to preserve their erosion-control value.
   6. Install erosion and sediment control practices where shown on the Drawings and according to applicable standards, codes and specifications. The practices shall be maintained in effective working condition during construction and until the drainage area has been permanently stabilized.
   7. Mulching to be used for temporary stabilization.
      a. Suitable Materials for Mulching:
         1) Unrotted straw or salt hay: 1-1/2 to 2 tons/acre.
         2) Asphalt emulsion or cutback asphalt: 600 to 1200 gal. /acre.
         3) Wood-fiber or paper-fiber (hydroseeding): 1500 lbs./ acre.
         4) Mulch netting (paper, jute, excelsior, cotton or plastic).
      b. Straw or salt hay mulches should be immediately anchored using peg and twine netting or a mulch anchoring tool or liquid mulch binders.
   8. After stabilization, remove all straw bale dikes, debris, etc., from the site.
   9. In the event of any temporary Work stoppage, take steps any temporary or environmental damage to the area undergoing construction.
   10. In the event CONTRACTOR repeatedly fails to satisfactorily control erosion and siltation, the OWNER reserves the right to employ outside assistance or to use

its own forces to provide the corrective measures indicated. The cost of such work, plus engineering costs, will be deducted from monies due CONTRACTOR.

11. Prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on and off-site damage and health hazards. Control may be achieved by irrigation in which the site shall be sprinkled with water until the surface is moist. The process shall be repeated as needed.

B. Drainage and Dewatering:
   1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, therein is inspected by the ENGINEER and backfill operations have been completed and approved.
      a. The different working areas on the site shall be kept free of surface water at all times. Install drainage ditches and dikes and shall perform all pumping and other Work necessary to divert or remove rainfall and all other accumulations of surface water from the excavations and fill areas. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.
      b. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the water downstream of the point of discharge, shall not be directly discharged. Such waters shall be diverted through a settling basin or filter before being discharged.
      c. Responsibility belongs to CONTRACTOR for the condition of any pipe, conduit or channel used for drainage purposes and all such pipes, conduits or channels shall be left clean and free of sediment.
      d. Remove water from excavations as fast as it collects.
   2. Provide, install and operate sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, etc., necessary to depress and maintain the ground water level below the base of the excavations during all stages of construction operations. The ground water table shall be lowered in advance of excavation, for a sufficient period of time so as to permit dewatering of fine grain soils, and maintained two feet below the lowest subgrade excavation made until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural ground water. The system shall be operated on a 24-hour basis and standby pumping facilities and personnel shall be provided to maintain the continued effectiveness of the system. If, in the opinion of the ENGINEER, the water levels are not being lowered or maintained as required by these Specifications, install additional or alternate dewatering devices as necessary, at no additional cost to the OWNER.
      a. Elements of the system shall be located so as to allow a continuous dewatering operation without interfering with the construction of the permanent Work. Where portions of the dewatering system are located in the area of permanent construction, submit details of the methods he proposes to construct the permanent Work in this location for the approval of the ENGINEER. Controls of ground water shall continue until the

permanent construction provides sufficient dead load to withstand the hydrostatic uplift of the normal ground water, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until all waterproofing Work has been completed. Dispose of all water removed from the excavation in such a manner so as not to endanger any portion of the Work under construction or completed. Convey water from the excavations in a closed conduit. Before discontinuing dewatering operations or permanently permitting the rise of the ground water level, computations shall be made to show that any structure affected by the water level rise is protected by backfill or other means to sustain uplift. Use a safety factor of 1.25 when making these computations.

b. Dewatering operations shall not be discontinued without the prior authorization of the ENGINEER.
c. Design of dewatering system, including both drawings and calculations, shall be performed by a Registered Professional Engineer in the State of Arizona and shall be employed by CONTRACTOR. Dewatering system shall be designed so as to avoid settlement or damage to existing structures and utilities.

C. Disposal of Water Removed by Dewatering System:
1. CONTRACTOR shall coordinate with the City for dewatering and discharge location, test in accordance with State and Federal regulations.
2. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
3. Dispose of water in such a manner as to cause no inconvenience to OWNER, ENGINEER, or others involved in Work about the site.
4. Convey water from the construction site in a closed conduit. Do not use trench excavations as temporary drainage ditches

3.7 SHEETING, SHORING AND BRACING FOR STRUCTURE EXCAVATIONS

A. General:
1. Used material shall be in good condition, not damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary work.
2. All timber used for breast boards (lagging) shall be new or used, meeting the requirements for Douglas Fir Dense Construction grade with a bending strength not less than 1500 psi or Southern Pine No. 2 Dense.
3. All steel work for sheeting, shoring, bracing, cofferdams etc., shall be designed in accordance with the provisions of the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", of the AISC except that field welding will be permitted.
4. Steel sheet piling shall be manufactured from steel conforming to ASTM A 328. Steel for soldier piles, wales and braces shall be new or used and shall conform to ASTM A 36.
5. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
6. Unless otherwise shown on the Drawings, specified, or ordered, all materials used for temporary construction shall be removed when Work is completed.

Such removal shall be made in a manner not injurious to the structure or its appearance or to adjacent Work.

7. Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops as required, but at least three feet below grade, and leave permanently in place.
8. The clearances and types of the temporary structures, insofar as they affect the character of the finished Work, and the design of sheeting to be left in place, will be subject to the approval of ENGINEER; but responsibility for the adequacy of all sheeting, shoring, bracing, coffer-damming, etc., belongs to CONTRACTOR.
9. Safe and satisfactory sheeting, shoring and bracing shall be the entire responsibility of CONTRACTOR.
10. All municipal, County, State and Federal ordinances, codes, regulations and laws shall be observed.

B. Sheeting Left in Place:
   1. Steel sheet piling shown on the Drawings to be left in place shall consist of rolled sections of the continuous interlocking type, unless otherwise approved. The type and design of the sheeting and bracing shall conform to the above specifications for all steel work for sheeting and bracing. Steel sheeting designated to be left in place shall be new.
   2. Steel sheet piling to be left in place shall be driven straight to the lines and grades as shown on the Drawings or directed. The piles shall penetrate into firm materials with secure interlocking throughout the entire length of the pile. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
   3. The type of guide structure used and method of driving for steel sheet piling to be left in place shall be subject to the approval of ENGINEER. Jetting will not be permitted.
   4. Cut off piling left in place to the grades shown on the Drawings or directed by ENGINEER and remove the cut offs from the site.
   5. Clean wales, braces and all other items to be embedded in the permanent structure, and ensure that the concrete surrounding the embedded element is sound and free from air pockets or harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and the welding of steel diaphragm waterstops perpendicular to the centerline of brace ends which are to be embedded.
   6. Subsequent to removal of the inside face forms, and when removal of bracing is permitted, cut back steel at least 2-inches inside the wall face and patch opening with cement mortar. Concrete shall be thoroughly worked beneath wales and braces, around stiffeners and in any other place where voids may be formed.
   7. Portions of sheeting or soldier piles and breast boards which are in contact with the foundation concrete shall be left in place, together with wales and bracing members which are cast into foundation or superstructure concrete.

C. Removal of Sheeting and Bracing:
   1. Remove sheeting and bracing from excavations, unless otherwise directed in writing by ENGINEER. Removal shall be done so as to not cause injury to the

Work. Removal shall be equal on both sides of excavation to ensure no unequal loads on pipe or structure.

2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
   a. Concrete has cured a minimum of seven days.
   b. Wall and floor framing up to and including grade level floors are in place.

3.8 TRENCH SHIELDS

A. Excavation of earth material below the bottom of a shield shall not exceed the limits established by ordinances, codes, laws and regulations.

B. When using a shield for the installation of structures, the bottom of the shield shall not extend below the top of the bedding for the structures.

C. When a shield is removed extreme care shall be taken to prevent damage to the structures or the disturbance of the bedding for structures. Structures that are disturbed shall be removed and reinstalled as specified.

3.9 PLACEMENT OF FILL AND BACKFILL

A. General:
   1. All select backfill and backfill required for structures, embankments, and ductbanks and required to provide the finished grades shown on the Drawings and as described herein shall be furnished, placed and compacted by CONTRACTOR. Refer to and comply with the requirements of Section 31 23 23.11, Crushed Stone and Gravel.
   2. Backfill excavations as promptly as Work permits, but not until completion of the following:
      a. Acceptance by the ENGINEER of construction below finish grade, including dampproofing, waterproofing and perimeter insulation.
      b. Inspection, testing, approval, and recording of locations of underground ductbanks.
      c. Removal of concrete formwork.
      d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
      e. Removal of trash and debris.
   3. Fill containing organic materials or other unacceptable material shall be removed and replaced with approved fill material as specified.

B. Placement of Select Backfill, Backfill and Fill:
   1. Select backfill shall be placed to the grades shown on the Drawings. The lift thickness and compaction moisture content range given herein are approximate. These values shall be finally determined from the laboratory test results on the fill materials. Testing requirements shall be as specified in Paragraph 3.9.E., below.
   2. All select backfill shall be placed in horizontal loose lifts, not exceeding 8-inches in thickness, and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each lift shall be compacted by not less than two complete coverages of the specified compactor. Select backfill shall be placed to the underside of all concrete slabs. The fill material shall extend a minimum

of two feet outside the face of each structure and be 12-inches below finished grade on all structures. The maximum slope of select backfill to the subgrade shall be one vertical to one horizontal.

3. Backfill and fill around and outside of structures and over select backfill shall be deposited in layers not to exceed 8-inches in uncompacted thickness and mechanically compacted, using platform type tampers. Compaction of structures backfilled by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of select backfill and/or backfill by inundation with water will not be permitted. All materials shall be deposited as specified herein and as shown on the Drawings.
4. The material shall be placed at a moisture content and density as specified under Paragraph 3.9.E., below. Provide equipment capable of adding measured amounts of water to the backfill and/or select backfill material to bring it to a condition within the range of the required moisture content. Provide equipment capable of discing, aerating, and mixing the soil to ensure reasonable uniformity of moisture content throughout the fill material and to reduce the moisture content of the borrow material by air drying, if necessary. If the subgrade or lift of earth material must be moisture conditioned before compaction, the fill material shall be sufficiently mixed or worked on the subgrade to ensure a uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.
5. No backfill or fill material shall be placed when free water is standing on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted. No fill shall be placed or compacted in a frozen condition or on top of frozen material. Any fill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved fill material prior to compaction.
6. Compaction shall be performed with equipment suitable for the type of fill material being placed. Select equipment that is capable of providing the minimum density required by these Specifications. Hand operated compacting equipment shall be used within a distance of ten feet from the wall of any completed below grade structure. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping. The effectiveness of the equipment selected shall be tested at the commencement of compacted fill Work by construction of a small section of fill within the area where fill is to be placed. If tests on this section of fill show that the specified compaction is not obtained, increase the amount of coverages, decrease the lift thicknesses and/or obtain a different type of compactor.
7. Levels of backfill against concrete walls shall not differ by more than two feet on either side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs. Particular care shall be taken to compact structure backfill, which will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to an elevation 12-inches above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

8. The compaction requirements specified are predicated on the use of normal materials and compaction equipment. In order to establish criteria for the placement of a controlled fill so that it will have compressibility and strength characteristics compatible with the proposed structural loadings, a series of laboratory compaction and/or compressive strength tests shall be performed on the samples of materials submitted by CONTRACTOR. From the results of the laboratory tests, the final values of the required percent compaction, the acceptable compaction moisture content range, and the maximum permissible lift thickness will be established for the fill material and construction equipment proposed.
9. Control the water content of fill material during placement within the range necessary to obtain the compaction specified. In general, the moisture content of the fill shall be within three percent of the optimum moisture content for compaction as determined by laboratory tests. Perform all necessary work to adjust the water content of the material to within the range necessary to permit the compaction specified. Do not place fill material when free water is standing on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted.
10. Compact fill shall be compacted by at least two coverages of all portions of the surface of each lift by compaction equipment. One coverage is defined as the condition obtained when all portions of the surface of the fill material have been subjected to the direct contact of the compactor.
11. If the specified densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment, perform whatever Work is required to provide the required densities. This Work shall include complete removal of unacceptable fill areas, and replacement and recompaction until acceptable fill is provided.
12. If any settlement occurs, repairs will be at CONTRACTOR'S expense. Make all repairs and replacements necessary within 30 days after notice from ENGINEER or OWNER.
13. Special attention is required to assure compaction under all piping to spring line, if the compaction process is not satisfactory to the ENGINEER. Refer to Trench Backfill Drawings for additional requirements.

C. Backfill in Electrical Ductbank Trenches:
   1. Compacted backfill shall be required for the full depth of the trench, below and above the electrical ductbank. Where the trench for one ductbank passes beneath the trench for another pipe or ductbank select backfill shall be placed to the level of the bottom of the upper trench.
   2. Placement and compaction of backfill in electrical ductbank trenches shall conform to the requirements of Paragraph 3.9.B., above.

D. Crushed Stone Placement:
   1. Crushed stone shall be placed where shown on the Drawings to the limits shown.
   2. Crushed stone shall be place in hand tamped lifts, not to exceed 6-inches.

E. Compaction Density Requirements:

1. The degree of compaction required for all types of fills shall be as listed below. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction.

Material Thick.(in)	Required Minimum Density-Percent Compaction (ASTM D 698)	*Maximum Uncompacted Lift (inches)
Subgrade and Subbase Fill:		
Below concrete slabs on grade	95	8
Below base of footings or mats, structural slabs and tank floors	95	8
Below asphalt concrete paving	95	12
**Structural Backfill:		
More than 5 feet below final grade	100	8
Less than 5 feet below grade	95	8
Aggregate Base Course:		
Below concrete slabs or mats	95	8
Below asphalt paving	100	8
Trench Backfill, below and above ductbanks	95	12

* Where applicable.

** Structural backfill shall not be used for support of facilities which are susceptible to damage from differential settlement of the fill section relative to walls.

All fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±three percent, with the following exceptions: On site clayey soils optimum to plus three percent.

Natural undisturbed soils or compacted soil subsequently disturbed or removed by construction operations shall be replaced with materials compacted as specified above.

2. CONTRACTOR'S testing service shall perform tests necessary to provide data for selection of fill material and control of placement water content.
3. Field density tests, to ensure that the specified density is being obtained, shall be performed by CONTRACTOR'S testing service during each day of compaction Work.
4. If the tests indicate unsatisfactory compaction, provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction Work shall be performed by CONTRACTOR, at no additional cost to the OWNER, until the specified compaction is obtained. This Work shall include complete removal of unacceptable (as determined by the ENGINEER) fill areas and replacement and recompaction until acceptable fill is provided.

F. Replacement of Unacceptable Excavated Materials: In cases where over-excavation for the replacement of unacceptable soil materials is required, the excavation shall be backfilled to the required subgrade with select backfill material

and thoroughly compacted as specified in Paragraph 3.9.E., above. Sides of the excavation shall be sloped in accordance to the maximum inclinations specified for each structure location.

3.10 EMBANKMENTS

A. To the maximum extent available, use excess earth obtained from structure and underground ductbank excavations for construction of embankments. Obtain additional material from borrow pits as necessary. After preparation of the embankment area, level and roll the subgrade so that surface materials of the subgrade will be compact and well bonded with the first layer of the embankment. All material deposited in embankments shall be free from rocks or stones, brush, stumps, logs, roots, debris, and organic or other objectionable materials. Construct embankments in horizontal layers not exceeding 8-inches in uncompacted thickness. Spread and level material deposited by excavating and hauling equipment prior to compaction. Thoroughly compact each layer by rolling or other method acceptable to the ENGINEER to 95 percent of the maximum density within the limits of 2 percent below to 2 percent above the optimum moisture content as determined by ASTM D 698. If the material fails to meet the density specified, compaction methods shall be altered. Wherever an excavation passes through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation 24-inches above the top of the trench before trench is excavated.

3.11 GRADING

A. General: Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown on the Drawings, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:
   1. Turfed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than 1-inch above or below the required subgrade elevations.
   2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1-inch above or below the required subgrade elevation.
   3. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straightedge.

D. Compaction:
   1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 PAVEMENT SUBBASE COURSE

A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
   1. Refer to Section 32 12 00, Bituminous Paving, for paving Specifications.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Shoulders: Place shoulders along edges of base course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each base course layer. Compact and roll at least a 12-inch width of shoulder simultaneously with compacting and rolling of each layer of base course.

D. Placing: Place base course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting base material during placement operations.
   1. When a compacted base course is shown on the Drawings to be 6-inches thick or less, place material in a single layer. When shown on the Drawings to be more than 6-inches thick, place material in equal layers, except no single layer more than 6-inches or less than 3-inches in thickness when compacted.

3.13 DISPOSAL OF EXCAVATED MATERIALS

A. Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away from the project site by CONTRACTOR and disposed of in compliance with ordinances, codes, laws and regulations at no additional cost to the OWNER. Refer to and comply with the requirements of Section 31 10 00, Site Clearing.

3.14 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

A. Place 1-1/2 inches of temporary bituminous pavement immediately after backfilling trenches in paved roadways which are to be retained for permanent use. Maintain the surface of the paved area over the trench in good and safe condition during progress of the entire Work, and promptly fill all depressions over and adjacent to the trench caused by settlement of backfilling. The permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise specified.

B. Pavement, gutters, curbs, sidewalks or roadways disturbed or damaged by the CONTRACTOR'S operations, except areas designated "New Pavement" or "Proposed Pavement", shall be restored by CONTRACTOR at his own expense to as good condition as they were previous to the commencement of the Work and in accordance with applicable local and state highway specifications.

3.15 TEMPORARY FENCING

A. Furnish and install a temporary fence surrounding his excavations and Work area, including the stockpile and storage areas. Fence shall have openings only at vehicular, equipment and worker access points.

B. Furnish and install a temporary screening fence as shown on the Drawings.

3.16 ENVIRONMENTAL PROTECTION AND RESTORATION

A. Refer to and comply with the requirements of Section 01 57 23, Stormwater Pollution Prevention Plan and Permits.

+ + END OF SECTION + +

Geotechnical Evaluation

Lift Station 40 Refurbishment
Northwest Corner of Ray Road and Interstate 10
Phoenix, Arizona

HDR

3200 East Camelback Road, Suite 350 | Phoenix, Arizona 85018

September 11, 2020 | Project No. 606504001





Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

September 11, 2020
Project No. 606504001

Mr. Jason Fort
HDR
3200 East Camelback Road, Suite 350
Phoenix, Arizona 85018

Subject: Geotechnical Evaluation
Lift Station 40 Refurbishment
Northwest Corner of Ray Road and Interstate 10
Phoenix, Arizona

Dear Mr. Fort:

In accordance with our proposal dated December 15, 2017, and your authorization, Ninyo & Moore has performed a geotechnical evaluation for the above-referenced site. The attached report presents our methodology, findings, conclusions, and recommendations regarding the geotechnical conditions at the project site.

Ninyo & Moore appreciates the opportunity to be of service to you on this project.

Respectfully submitted,
NINYO & MOORE

Rachelle E. Mason, EIT
Senior Staff Engineer

Steven D. Nowaczyk, PE
Managing Principal Engineer

REM/SDN/tlp

Distribution: (1) Addressee (via e-mail)

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1 INTRODUCTION

In accordance with our proposal dated December 15, 2017, and your authorization, we have performed a geotechnical evaluation for the proposed Lift Station 40 Refurbishment Project to be located in Phoenix, Arizona. The purpose of our evaluation was to assess the subsurface conditions at the project site in order to provide geotechnical recommendations for design and construction. This report presents the results of our evaluation, and our geotechnical considerations and recommendations regarding the proposed construction.

2 SCOPE OF SERVICES

The scope of our services for this project generally included:

- Reviewing readily available geotechnical data, aerial photographs, and published geologic literature, including maps and reports pertaining to the project site and vicinity.
- Conducting a geologic reconnaissance of the site.
- Marking out the boring location at the project site, securing permission to drill.
- Notifying Arizona 811 of the boring location prior to drilling.
- Drilling, logging, and sampling one exploratory boring to a depth of approximately 50 feet below ground surface (bgs). The boring log are presented in Appendix A.
- Collecting soil samples in the boring at approximately 2.5 and 5.0-foot intervals using ASTM International (ASTM) Methods D1586 (Standard Penetration Test with split-spoon barrel sampling of soils) and D3550 (ring-lined barrel sampling of soils) for laboratory testing and analysis.
- Performing laboratory tests on selected samples obtained from the boring to evaluate in-situ moisture content and dry density, particle-size gradation, Atterberg limits, consolidation, direct shear and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). The in-situ moisture content and dry density results are presented on the boring log in Appendix A. The remainder of the laboratory test results are presented in Appendix B.
- Preparing this report presenting our findings, conclusions, and recommendations regarding the design and construction of the project.

Our scope of services did not include environmental consulting services such as hazardous waste sampling or analytical testing at the site. A detailed scope of services and estimated fee for such services can be provided upon request.

3 SITE DESCRIPTION

The project site is located at the northwest corner of Ray Road and Interstate 10 in Phoenix, Arizona (Figure 1). At the time of our evaluation, the site consisted of an active City of Phoenix (COP) Lift Station, numbered 40. Lift Station 40 is a wet pit/dry pit facility that conveys wastewater via force main north approximately 3.1 miles to a gravity sewer at Guadalupe Road, east of 48th Street. A control building, chemical building and standby generator also occupy the site. The site was bound by the Interstate 10 southbound off-ramp to the west and north, mainline Interstate 10 to the east, and Ray Road to the south.

According to the Guadalupe, Arizona 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Map (2018), the site is at an average elevation of roughly 1,230 feet relative to mean sea level (MSL). Based on information from this topographic quadrangle map, the ground surface at the site vicinity gently slopes from the west to the east.

4 AERIAL PHOTOGRAPH REVIEW

Aerial photographs dated 1937 through 2018 from the Maricopa County website were reviewed for this project. A summary of the observations noted for each aerial photograph is presented in Table 1:

Table 1 – Summary of Aerial Photograph Review

Photograph Date(s)	Site	Adjacent Properties	
1937, 1949, 1953, 1959	Undeveloped land.	North:	Undeveloped land.
		South:	Highline canal, Ray Road and agricultural land.
		East:	Highline canal and agricultural land.
		West:	Undeveloped land.
1976, 1979, 1982	Lift Station.	North:	Undeveloped land and Interstate 10.
		South:	Entrance road to lift station and Ray Road.
		East:	Interstate 10.
		West:	Undeveloped land.
1986	Lift Station with additions.	North:	Construction of southbound Interstate 10 off-ramp.
		South:	Construction of Ray Road over Interstate 10.
		East:	Interstate 10.
		West:	Construction of southbound Interstate 10 off-ramp.

Table 1 – Summary of Aerial Photograph Review			
Photograph Date(s)	**Site**	**Adjacent Properties**	
1991, 1993, 1996, 1998, 2000, 2001, 2003, 2004	Lift Station with additions.	North:	Southbound Interstate 10 off-ramp.
		South:	Ray Road.
		East:	Interstate 10.
		West:	Southbound Interstate 10 off-ramp.
2006, 2007	Lift Station with construction of new additions.	North:	Southbound Interstate 10 off-ramp.
		South:	Ray Road.
		East:	Interstate 10.
		West:	Southbound Interstate 10 off-ramp.
2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	Lift Station with additions.	North:	Southbound Interstate 10 off-ramp.
		South:	Ray Road.
		East:	Interstate 10.
		West:	Southbound Interstate 10 off-ramp.

5 PROPOSED CONSTRUCTION

We understand that the Lift Station 40 Facility was originally constructed in 1975. The project includes the design and construction of a new wet well and above grade discharge piping connecting the force main, rehabilitation or replacement of pumps and associated appurtenances, influent gravity sewer relocation, and miscellaneous site improvements, including drainage. These improvements may extend as deep as 23 feet below the current site grades.

Structural loading was not available at the time of our report. We assume the loading will be typical for these type of structures and that the new foundation system for this development will consist of shallow spread-type footings and slabs. We assume positive drainage will be established during and after construction at the site.

6 FIELD EXPLORATION AND LABORATORY TESTING

On August 13, 2020, Ninyo & Moore conducted a subsurface exploration at the site in order to evaluate the subsurface conditions and to collect soil samples for laboratory testing. Our evaluation consisted of drilling, logging, and sampling of one small-diameter boring using a CME-75 truck-mounted drill rig equipped with hollow-stem augers. The boring, denoted as B-1, extended to a depth of approximately 50 feet bgs (Figure 2). Bulk and relatively undisturbed soil

samples were collected at selected intervals. Descriptions of the soils encountered are presented in the boring log in Appendix A.

The soil samples collected from our drilling activities were transported to the Ninyo & Moore laboratory in Phoenix, Arizona. In addition, Ninyo & Moore performed laboratory tests on selected samples obtained from the boring to evaluate the in-situ moisture content and dry density, particle-size gradation, Atterberg limits, consolidation, direct shear, corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents).

The in-situ moisture content and dry density results are presented on the boring log in Appendix A. A description of the laboratory testing as well as the remainder of the laboratory test results are presented in Appendix B.

7 GEOLOGY AND SUBSURFACE CONDITIONS

The geology and subsurface conditions at the site are described in the following sections.

7.1 Geologic Setting

The project site is located in the Sonoran Desert Section of the Basin and Range physiographic province, which is typified by broad alluvial valleys separated by steep, discontinuous, subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 10 to 18 million years ago during the Mid- to Late-Tertiary. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with alluvium from the erosion of the surrounding mountains as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is described as Holocene (Present to 10,000 years) age alluvial channel, fan, and terrace deposits (Pearthree and Huckleberry, 1994). The United States Department of Agriculture Web Soil Survey described the site as generally consisting of Gilman Loam. Loam is an agriculture soil classification that refers to a soil comprised of a mixture of clay, silt, and sand.

7.2 Subsurface Conditions

Our knowledge of the subsurface conditions at the project site is based on the results of our exploratory boring and our understanding of the general geology of the area. The boring log contains our field test results, as well as our interpretation of the conditions likely to exist between actual samples retrieved. Therefore, the boring log contains both factual and interpretive information. Lines delineating subsurface strata on the boring log are intended to group soils having similar engineering properties and characteristics. They should be considered approximate, as the actual transition between soil types may be gradual. Detailed stratigraphic information as well as a key to the soil symbols and terms used on the boring log are provided in Appendix A.

7.2.1 Fill

Undocumented fill soils were encountered at the ground surface in Boring B-1 and was approximately 8 feet thick. The fill generally consisted of loose clayey sands (SC) with varying amounts of gravel in our borings.

7.2.2 Alluvium

Native alluvium soil was encountered at the ground surface in Boring B-1, and extended to the boring termination depth. In our boring, the alluvium generally consisted of medium dense to very dense clayey sands (SC). Varying quantities of scattered caliche was also observed in our boring.

7.2.3 Groundwater

Groundwater was not encountered in our boring. Based on well data from the Arizona Department of Water Resources, the depth to groundwater has been estimated to be about 150 feet bgs. Groundwater levels can fluctuate due to seasonal variations, irrigation, groundwater withdrawal or injection, and other factors. In general, groundwater is not anticipated to be a constraint to the construction of the project.

8 GEOLOGIC HAZARDS

The following sections describe regional geologic hazards, including land subsidence, earth fissures, faults, and liquefaction.

8.1 Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land. From 1948 to 1983, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation resulting in large areas of land subsidence (Schumann and Genualdi, 1986).

In Arizona, earth fissures are generally associated with land subsidence and pose an ongoing geologic hazard. Earth fissures generally form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Earth fissures form due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces.

Based on our field reconnaissance and review of the referenced material, there are no known or exposed earth-fissures present at the subject site. The closest documented earth fissure to this site is approximately 15 miles to the southeast of the site (AZGS, 2017). Continued groundwater withdrawal in the area may result in subsidence of the valley and the formation of new fissures or the extension of existing fissures. In general, land subsidence and earth fissures are not considered to be a constraint to development on this project site.

8.2 Faulting and Seismicity

The site lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations, review of pertinent geologic data, and analysis of aerial photographs, Quaternary faults are not located on or adjacent to the property.

The closest documented Quaternary fault to the site is the Carefree Fault Zone, located approximately 32 miles to the northeast of the site (Pearthree, 1998). Approximately 2 meters of displacement has occurred along this fault within middle to late Pleistocene deposits (200,000 to 750,000 years), but the Holocene deposits (<250,000 years) are not displaced. Seismic design considerations are provided in Section 10.2.

9 GEOTECHNICAL CONSIDERATIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, it is our opinion that the proposed construction is feasible from a geotechnical standpoint, provided that the recommendations of this report are incorporated into the design and construction of the proposed project, as appropriate. Geotechnical considerations include the following:

- Approximately 8 feet of undocumented fill soils were observed at the surface of our boring.
- The undocumented fill present on site is prone to sudden volume changes upon inundation with water. These materials are not considered suitable to provide foundation support to the proposed new improvements.
- Earthwork contractors should be made aware of the moisture sensitivity of the near surface silty and clayey soils and potential compaction difficulties.
- The near-surface on-site materials are considered generally excavatable with heavy-duty earthmoving equipment. Very dense sands, as well as varying amounts of gravel and caliche were encountered in our boring at various depths, which could be more difficult to excavate during construction.
- Imported soils and soils generated from on-site excavation activities that exhibit relatively low plasticity and low organic contents can generally be used as engineered fill. Some of the on-site soils are considered to be suitable for re-use as engineered fill.
- The new structures may be supported on spread footings proportioned for moderate bearing pressures on a zone of engineered fill.
- Soil conditions that differ from what was encountered in our boring may be encountered during construction.
- Groundwater was not observed in our boring. The static groundwater table is anticipated to be approximately 150 feet bgs based on the nearby well data.
- No known or reported geologic hazards are present underlying or immediately adjacent to the site.

10 RECOMMENDATIONS

The following sections present our geotechnical recommendations and were developed based on our understanding of the proposed construction (Section 5), the observed subsurface conditions (Section 7.2), and our experience. If the proposed construction is changed from that discussed herein or subsurface conditions other than those shown on the boring log (Appendix A) are observed at the time of construction, Ninyo & Moore should be retained to conduct a review of the new information and to evaluate the need for additional recommendations.

10.1 Earthwork

In general, the recommendations and guidelines outlined in the Maricopa Association of Governments (MAG) Standard Specifications and Details and/or any COP supplement should be used unless recommended differently herein. If the proposed construction is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations. Soil conditions not observed in our boring may be encountered during construction.

10.1.1 Site Preparation

Prior to placing any fill, pavement, or flatwork, the following guidelines should be followed:

- Obstructions that extend below finish grade, if any, should be removed and the resulting holes filled with compacted soil.
- After stripping, clearing, grubbing, and root raking is performed and prior to placement of any fill soils, the exposed subgrade should be evaluated by proof-rolling. Any soft or weak areas observed during the proof-rolling process should be removed and replaced with compacted material as outlined in Section 10.1.11.
- Proof-rolling should be accomplished with a pneumatic-tired roller, a loaded dump truck, or similar equipment weighing approximately 20 tons and observed by the Geotechnical Engineer-of-Record, or the Engineer's designated representative.

Due to the clayey nature of the surficial soils, traffic of heavy equipment (including heavy compaction equipment) may create pumping and general deterioration of shallow soils. Therefore, some construction difficulties should be anticipated, especially during periods when these soils are wet.

10.1.2 Wet Weather Conditions

Earthwork contractors should be made aware of the moisture sensitivity of the near surface silty and clayey soils and potential compaction difficulties. If construction is undertaken during wet weather conditions, the surficial soils may become saturated, soft, and unworkable. Therefore, we recommend that consideration be given to construction during the dryer months and positive drainage be established and maintained during construction.

10.1.3 Subgrade Improvement

We recommend that new foundations associated with the heavily-loaded improvements (that are planned to be situated approximately 20 feet deep) be supported on a zone of adequately moisture conditioned and compacted engineered fill that extends 6 inches

below the foundation level. This improvement zone should be moisture conditioned and compacted in accordance with Section 10.1.11 of this report.

New lightly-loaded improvements (that are planned to be situated at-grade) should be supported on 3 feet of moisture-conditioned and compacted engineered fill. This improvement zone should extend 3 foot horizontally beyond the edges of the lightly-loaded improvements and should be moisture conditioned and compacted in accordance with Section 10.1.11 of this report.

New at-grade slabs and flatwork areas should be supported on 12 inches of moisture-conditioned and compacted engineered fill. The improvements in these areas should extend 1 foot horizontally beyond the edges of the flatwork.

Prior to the placement of new engineered fill, the geotechnical consultant should carefully evaluate the resulting exposed surface. Based on this evaluation, additional remediation may be needed. This could include scarification of the exposed surface. This additional remediation (if needed) should be resolved by the geotechnical consultant during the earthwork operations.

10.1.4 Excavations

Our evaluation of the excavation characteristics of the on-site materials is based on the results of our exploratory boring, site observations, and experience with similar materials. Excavation of the materials can generally be accomplished with heavy-duty earthmoving equipment. However; very dense sands, as well as varying amounts of gravel and caliche were encountered in our boring and may be more difficult to excavate and/or slow the rate of excavation during construction.

The contractor should provide safely sloped excavations or an adequately constructed and braced shoring system, in compliance with Occupational Safety and Health Administration (OSHA) regulations for employees working in an excavation that may expose employees to the danger of moving ground. If material is stored or equipment is operated near an excavation, stronger shoring should be used to resist the extra pressure due to superimposed loads.

The contractor should provide safely sloped excavations or an adequately constructed and braced shoring system in compliance with OSHA Regulations for employees working in an excavation that may expose them to the danger of moving ground. Based on the soil conditions at the site, we recommend that OSHA Soil “Type C” classification be used for

excavations at the site. This corresponds to temporary slopes of 1.5:1 (horizontal: vertical). This side slope is for excavations that are less than 20 feet deep. If material is stored or equipment is operated near an excavation, stronger shoring should be used to resist the extra pressure due to superimposed loads.

If the proposed construction extends deeper than the extent of our test boring in any part of this project, Ninyo & Moore should be contacted for additional consultation and possible further evaluation of the subsurface materials.

10.1.5 Vertical Shoring and Trench Boxes

Because of the cohesionless nature of some of the on-site soils, the proposed depths of the excavations, and presence of existing utilities and structures (e.g., roadways, utilities, and buildings), it may be preferable to shore or brace new excavations rather than using open cuts to the base of the excavations. Temporary earth retaining systems will be subjected to lateral loads resulting from earth pressures. Shored and braced trench excavations may be designed using the parameters on Figure 3.

The earth pressure values presented on Figure 3 assume that spoils from the excavation or other surcharge loads will not be placed above the excavation within a 1:1 (H:V) plane extending up and back from the base of the excavation. If spoil piles are placed closer than this to the braced excavation, the resulting surcharge loads should be considered in the bracing design. We recommend that an experienced structural engineer design the shoring system. The shoring parameters presented in this report should be considered as guidelines.

The contractor should anticipate repairing cracks in pavements adjacent to shored portions of the excavation due to anticipated lateral displacements of the shoring system. Horizontal and vertical movements of the shoring system should be monitored by a surveyor and the results reviewed by the project Geotechnical Engineer.

Trench boxes may also be a suitable alternative to laying back the side walls; however, due to the presence of granular soils, the excavations may not stand open long enough to install the trench boxes. The contractor should be prepared to deal with these soil conditions and plan accordingly. Once installed, some sloughing is possible at the ends of the trench box; therefore, any loose material should be removed prior to backfilling of the trench.

10.1.6 Bottom Stability

The proposed excavations are not anticipated to encounter significant groundwater (with the possible exception of surface run-off or perched zones) during construction. Therefore, trench bottom stability problems during construction are generally not anticipated at this site. However, if excavations are to be located within the wash or floodplain, if the excavations are open during a heavy rain event, the trench material(s) might become saturated and unstable and a dewatering system may be needed for these conditions. Should this occur, further remedial measures may be needed.

10.1.7 Construction Dewatering

Surface run-off, and perched groundwater will vary seasonally depending on irrigation and rainfall in the site vicinity. Excavations that do encounter surface run-off (if any) could be dewatered by pumping the water out from the bottom and away from the excavation. However, heavily saturated units or perched groundwater zones, if encountered, may call for more aggressive means of dewatering and consultation with a qualified expert. Discharge of water from the excavations to natural drainage channels may entail securing a special permit.

10.1.8 Fill Materials

On-site and imported soils that exhibit relatively low plasticity indices are generally suitable for re-use as engineered fill. Relatively low plasticity indices, as evaluated by ASTM D4318, are defined as a plasticity index (PI) of 15 or less for this project.

In addition, suitable fill should not include construction debris, organic material, or other non-soil fill materials. Clay lumps and rock particles should not be larger than 4 inches in dimension. Unsuitable fill material should be disposed of off-site or in non-structural areas.

Imported fill, if used, should consist of soils with a relatively low PI (15 or less). Import material in contact with ferrous metals should preferably have low corrosion potential (minimum resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million [ppm]). In lieu of this, corrosion protection techniques (e.g., cathodic protection, pipe wrapping, etc.) can be implemented. A corrosion specialist should be consulted for recommendations of an appropriate corrosion protection technique. Imported material in contact with concrete should have a soluble sulfate content of less than 0.1 percent. The geotechnical consultant should evaluate such materials and details of their placement prior to importation.

10.1.9 Re-use of On-Site Soils

The Atterberg limits tests performed on soil samples obtained from our boring resulted in PI ranging from 10 to 17. Based on our test results, some of the on-site soils are considered suitable for re-use as engineered fill for this project. Additional field sampling and laboratory testing should be conducted by the contractor either prior to or during construction to better screen for unsuitable materials.

10.1.10 Pipe Bedding and Modulus of Soil Reaction (E')

We recommend new pipelines being installed using cut-and-cover techniques be supported on 4 inches, or 1/12th the outside diameter of the pipe, (whichever is thicker) or more of granular bedding material such as sand and gravel, or crushed rock meeting the MAG Section 702 Standard Specifications (pea gravel or crushed chips are not acceptable). This bedding/pipe-zone backfill should extend 1 foot above the pipe crown. Care should be taken not to allow voids to form beneath the pipe (i.e., the pipe haunches should be continuously supported) to avoid damaging the pipeline. This may involve fill placement by hand or small compaction equipment. The pipe bedding should be moisture-conditioned and compacted as discussed in Section 10.1.11 Pipe bedding guidelines are presented on Figure 4.

The modulus of soil reaction (E´) is used to characterize the stiffness of soil backfill placed on the sides of buried pipelines for the purpose of evaluating deflection caused by the weight of the backfill over the pipe. Based on MAG guidelines, the definition of "granular backfill" material is material which the sum of the PI and the percent of material passing a No. 200 sieve does not exceed 23.

E' for native materials will vary with material type and stiffness of the trench sidewalls. Approximate values of E' for the materials encountered in our boring are presented in Table 2 below:

Table 2 – Modulus of Soil Reaction (E') for Native Soils

Trench Wall Soil Classification (USCS)	Approximate E' (psi)		
	Loose/Firm	Medium Dense/ Stiff	Dense – Very Dense/ Stiff-Hard
Silty/Clayey Sand and Gravel (SM, SC, SC/SM, GC)	400	700	2500

10.1.11 Fill Placement and Compaction

Engineered fill should be moisture-conditioned within the moisture range shown below in Table 3 and mechanically compacted to the percent compaction shown. Engineered fill should generally be placed in 8-inch-thick loose lifts such that each lift is firm and non-yielding under the weight of construction equipment.

Engineered fill used to raise grade will settle a portion of its height due to its own weight prior to construction of the foundation systems. The magnitude of this settlement will depend on the type of fill used. In general, the engineered fill recommended in this report is expected to settle about 1 percent of its height.

Table 3 – Compaction Recommendations

Engineered Fill Description	Percent Compaction per ASTM D698	Moisture Content
Below foundations, floor slabs, and exterior flatwork	95 percent	-1% to +2 percent of optimum
Granular Trench Backfill – Within 2 feet below pavements	100 percent	±2 percent of optimum
Non-Granular* Trench Backfill – Within 2 feet below pavement	95 percent	-1% to +2 percent of optimum
Trench Backfill – Deeper than 2 feet below pavement	95 percent	

Note:
*Based on MAG guidelines, the definition of "granular backfill" materials is material in which the sum of the PI and the percent of material passing a No. 200 sieve does not exceed 23.

An earthwork (shrinkage) factor of 10 to 20 percent is estimated. This shrinkage factor range represents an average of the material tested and assumes that materials excavated from the site will be placed as fill. Potential bidders should consider this in preparing estimates and should review the available data to make their own conclusions regarding excavation conditions.

10.1.12 Controlled Low Strength Material (CLSM)

As an alternative to engineered fill, the backfill zones may be filled with either CLSM. CLSM consists of a fluid, workable mixture of aggregate, Portland cement, and water. The use of CLSM has some advantages:

- A narrower backfill zone can be used, thereby minimizing the quantity of soil to be excavated and possibly reducing disturbance to the near-by structures.
- Relatively higher E' values may be used (E'= 3,000 psi).

- The support given to the connecting pipes is generally better.
- Because little compaction is needed to place CLSM, there is less risk of damaging the connecting pipes.
- CLSM can be batched to flow into irregularities in the trench bottom and walls.

The CLSM design mix should be in accordance with current MAG or Standard Specifications for Public Works Construction standards. Additional mix design information can be provided upon request.

Buoyant or uplift forces on the piping should be considered when using CLSM and prudent construction techniques may result in multiple pours to avoid inducing excessive uplift forces. Sufficient time should be provided to allow the CLSM to cure before placing additional lifts of CLSM or trench backfill.

10.2 Seismic Design Parameters

Design of the proposed improvements should be performed in accordance with the requirements of the governing jurisdictions and applicable building codes. Table 4 presents the seismic design parameters for the site in accordance with ASCE 7 guidelines and adjusted maximum considered earthquake spectral response acceleration parameters evaluated using the USGS ground motion calculator (web-based):

Table 4 – ASCE 7 Seismic Design Criteria

Seismic Design Factors	Value
Site Class	D
Site Coefficient, F_a	1.6
Site Coefficient, F_v	2.4
Mapped Spectral Response Acceleration at 0.2-second Period, S_s	0.173 g
Mapped Spectral Response Acceleration at 1.0-second Period, S_1	0.064 g
Spectral Response Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	0.277 g
Spectral Response Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.153 g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.184 g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.102 g

10.3 Foundations

Based on the results of the field and laboratory evaluations, it is our opinion that the proposed structures can be founded on spread footing or mat foundations. Recommendations for these foundation systems are presented in the following sections of this report.

10.3.1 Spread Footings

Spread or continuous footings, if utilized, should be supported at a depth of 18 inches or more below the adjacent finished grade. The footings should be supported on engineered fill, as described in Section 10.1.3. Continuous footings should have a width of 18 or more inches, and isolated spread footings should have a width of 24 or more inches. Spread or continuous footings should be reinforced in accordance with the recommendations of the structural engineer.

Based on the available soil boring information, spread footings supported on engineered fill may be designed using a net allowable bearing capacity of 3,000 pounds per square foot (psf) for static conditions. Total and differential settlement of up to about 1 inch and ½ inch respectively, may occur.

Foundations bearing on moisture-conditioned, compacted engineered fill that are subject to lateral loadings may be designed using an ultimate coefficient of friction of 0.40 (total frictional resistance equivalent to the coefficient of friction multiplied by the dead load). A passive resistance value of 350 psf per foot of depth can be used. The lateral resistance can be taken as the sum of the frictional resistance and passive resistance, provided that the passive resistance does not exceed one-half of the total allowable resistance. The passive resistance may be increased by one-third when considering loads of short duration such as wind or seismic forces. The foundations should preferably be proportioned such that the resultant force from lateral loadings falls within the kern (i.e., middle one-third).

10.3.2 Mat Foundations

Reinforced concrete mat foundations may be used as an alternative to spread footings. Based on the available soil boring information, mat foundations may be designed using a net allowable bearing capacity of 2,500 psf for static conditions and a Modulus of Subgrade reaction of 200 pounds per cubic inch. Total and differential settlement of up to about 1 inch and ½ inch respectively, may occur. Differential settlements will depend upon the structural rigidity of the mat. For settlement sensitive structures that call for settlements less than the values provided above, we recommend that the structures be supported on deep foundations such as cast-in-place drilled shafts. Detailed settlement analyses should be

performed during the design phase of the project when the actual building location and dimensions have been established. Recommendations related to cast-in-place drilled shafts (if needed) are not included in this report and can be provided under a separate cover letter.

10.4 Grade Slabs

The design of the at-grade slabs and floor slabs is the responsibility of the structural engineer. However, from a geotechnical standpoint, we recommend that floor slabs have a thickness of 4 or more inches and be reinforced per the Structural Engineer's recommendation. Placement of the reinforcement in the slab is vital for satisfactory performance. The floor slabs should be underlain by 4 or more inches of moist clean sand or compacted aggregate base, which should be underlain by engineered fill as described in this report. The need for a moisture-retarding system and/or vapor retarding system should be evaluated by the structural engineer or architect based on the moisture sensitivity of the anticipated flooring. Grade slabs should be designed using a Modulus of Subgrade reaction of 200 pounds per cubic inch.

Floor slabs should either be constructed so that they "float" independent of the foundations or be designed to be structurally connected to the foundations. Structurally reinforced slabs with thickened, integral footings should be considered. Soils underlying the slabs should be moisture-conditioned and compacted in accordance with the recommendations in Section 10.1.11. Joints should be constructed at intervals designed by the structural engineer to help reduce random cracking of the slab.

10.5 Below-Grade Walls

Earth pressures are used to compute the lateral forces acting on below-grade and retaining structures and foundations. These pressures can be classified as at-rest, active, and passive. The direction and magnitude of the soil/wall movement just before failure affects the resulting pressure condition. At-rest conditions exist when there is no movement, such as for a restrained wall. Active stresses are exerted when the wall moves out and the soil moves toward the wall away from the soil mass, thereby mobilizing the shear strength of the soil. The active pressures are fully mobilized at horizontal movements of about 0.1 percent of the wall height for cohesionless soils such as sands and gravels. Passive stresses exist when the wall moved toward the soil mass. Movement typically needed to mobilize passive pressures greatly exceeds that needed to mobilize active pressures. The passive pressure are, therefore, rarely fully mobilized and are often overestimated when used to compute resistance forces. The recommended equivalent fluid pressures in Table 5 assume horizontal, free-draining,

unsaturated granular backfill, with an angle of internal friction of 30 degrees, a unit weight equal to about 120 pcf, and static conditions.

Table 5 – Lateral Earth (Equivalent Fluid) Pressures

Soil Condition	Active Pressure (pcf)	At-rest Pressure (pcf)	Passive Pressure (pcf)
Unsaturated	40	60	360
Saturated	19 (plus hydrostatic)	29 (plus hydrostatic)	--

The use of heavy compaction equipment adjacent to below-grade walls could result in lateral earth pressures well in excess of those predicted in Table 5.

The pressures given in the first row of the table above are for unsaturated conditions. If water is allowed to accumulate behind the walls, then hydrostatic pressure should be added to the pressures of the saturated pressures shown in the second row of Table 5. Hydrostatic pressure should be calculated as a triangular area. The lower leg of this triangle should start at the bottom of the wall with its pressure at this depth equivalent to 62.4 times the height of the groundwater column above this depth. The hydrostatic pressure should linearly increase with increasing depth. The top of the triangle should extend to the surface of the highest groundwater level, at which point the hydrostatic pressure will be zero.

Measures should be taken so that moisture does not build up behind the below-grade walls unless hydrostatic pressures are incorporated into the structural design. If desired, back drainage measures may be used and could include free-draining backfill material and perforated drain pipes or weepholes. Below-grade and retaining walls should be dampproofed or waterproofed in accordance with the recommendations of the project civil engineer. Waterstops and keyways should be used at construction and expansion joints.

Unless walls are designed to withstand hydrostatic forces, backfill material used within 18 inches behind below-grade and above-grade retaining walls should preferably consist of well-graded granular soils, with less than 5 percent passing the No. 200 sieve. Figure 5 provides typical details regarding the design and construction of below-grade wall and retaining wall drains. This material should be in intimate contact with the wall's bac drainage systems. We recommend that the upper 24 inches of soil not protected by pavement or a concrete slab, be neglected when calculating passing resistance. For frictional resistance to lateral loads, we recommend that an ultimate coefficient of friction of 0.35 be used between soil and concrete.

10.6 Corrosion

The corrosion potential of the on-site materials was tested to evaluate its potential effect on the foundations and structures. Our corrosion evaluation of the on-site soils is based on the results of our field and laboratory testing done for this project. A corrosion specialist should perform their own analysis.

Laboratory testing consisted of pH, minimum electrical resistivity, and chloride and soluble sulfate contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236c, while sulfate and chloride tests were performed in accordance with Arizona Test 733 and 736, respectively. The results of these corrosivity tests are presented in Appendix B.

The soil pH value of the selected sample tested from our boring was 7.9, which is considered to be alkaline. The minimum electrical resistivity of the sample tested was 3,551 ohm-cm, which is considered non-corrosive to ferrous materials. The chloride content of the sample tested was 6 ppm, which also indicates a non-corrosive environment for ferrous materials. The soluble sulfate content of the soil samples tested was 0.002, which is considered to represent negligible sulfate exposure for concrete.

Notwithstanding the results of the laboratory testing and to reduce the corrosion potential of buried metallic utilities, we recommend that topsoil, organic soils, soils, and mixtures of sand and clay not be placed adjacent to buried metallic utilities. Rather, we suggest that sand or gravel be placed around buried metal piping. Also, buried utilities of different metallic construction or operating temperatures should be electrically isolated from each other to minimize galvanic corrosion problems. In addition, new piping should be electrically isolated from old piping, if any, so that the old metal will not increase the corrosion rate of the new metal. A corrosion specialist should be consulted for further recommendations.

10.7 Concrete

Laboratory chemical tests performed on an on-site soil sample indicated a sulfate content of 0.002 percent by weight, which represents a negligible sulfate exposure for concrete. Based on the following American Concrete Institute (ACI) table (Table 6), the on-site soils should be considered to have negligible sulfate exposure to concrete. Based on the sulfate test results, and based on our experience with similar soil conditions, the specific use of the facility, and nearby practice, we however recommend the use of sulfate resistant cement (Type II or similar) for construction of concrete structures at this site. Due to potential uncertainties as to the use of

reclaimed irrigation water, or topsoil that may contain higher sulfate contents, pozzolan or admixtures designed to increase sulfate resistance may be considered.

Table 6 – ACI Requirements for Concrete Exposed to Sulfate-Containing Soil

Sulfate Exposure	Water-Soluble Sulfate (SO_4) in Soil, Percentage by Weight	Cement Type	Water-Cementitious Materials Ratio, by Weight, Normal-Weight Aggregate Concrete[1]	f'c, Normal-Weight and Lightweight Aggregate Concrete, psi x 0.00689 for MPa
Negligible	0.00 - 0.10	--	--	--
Moderate[2]	0.10 - 0.20	II, IP(MS), IS (MS)	0.50 or less	4,000 or more
Severe	0.20 - 2.00	V	0.45 or less	4,500 or more
Very severe	Over 2.00	V plus pozzolan[3]	0.45 or less	4,500 or more

Notes:

[1] A lower water-cementitious materials ratio or higher strength may be needed for low permeability or for protection against corrosion of embedded items or freezing and thawing (ACI Table 4.2.2).

[2] Seawater.

[3] Pozzolan that has been evaluated by test or service record to improve sulfate resistance when used in concrete containing Type V cement.

We recommend that the structural concrete have a water-cementitious materials ratio no more than 0.50 by weight for normal weight aggregate concrete. The structural engineer should ultimately select the concrete design strength based on the project specific loading conditions. Higher strength concrete may be selected for increased durability and resistance to slab curling and shrinkage cracking.

10.8 Pre-Construction Conference

We recommend that a pre-construction conference be held. Representatives of the owner, civil engineer, the geotechnical consultant, and the contractor should be in attendance to discuss the project plans and schedule. Our office should be notified if the project description included herein is incorrect, or if the project characteristics are significantly changed.

10.9 Construction Observation and Testing

During construction operations, we recommend that a qualified geotechnical consultant perform observation and testing services for the project. These services should be performed to evaluate exposed subgrade conditions, including the extent and depth of overexcavation, to evaluate the suitability of the on-site materials for use as fill and to observe placement and test compaction of fill soils. If another geotechnical consultant is selected to perform observation and

testing services for the project, we request that the selected consultant provide a letter to the owner, with a copy to Ninyo & Moore, indicating that they fully understand our recommendations and they are in full agreement with the recommendations contained in this report. Qualified subcontractors utilizing appropriate techniques and construction materials should perform construction of the proposed improvements.

11 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may

occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

12 REFERENCES

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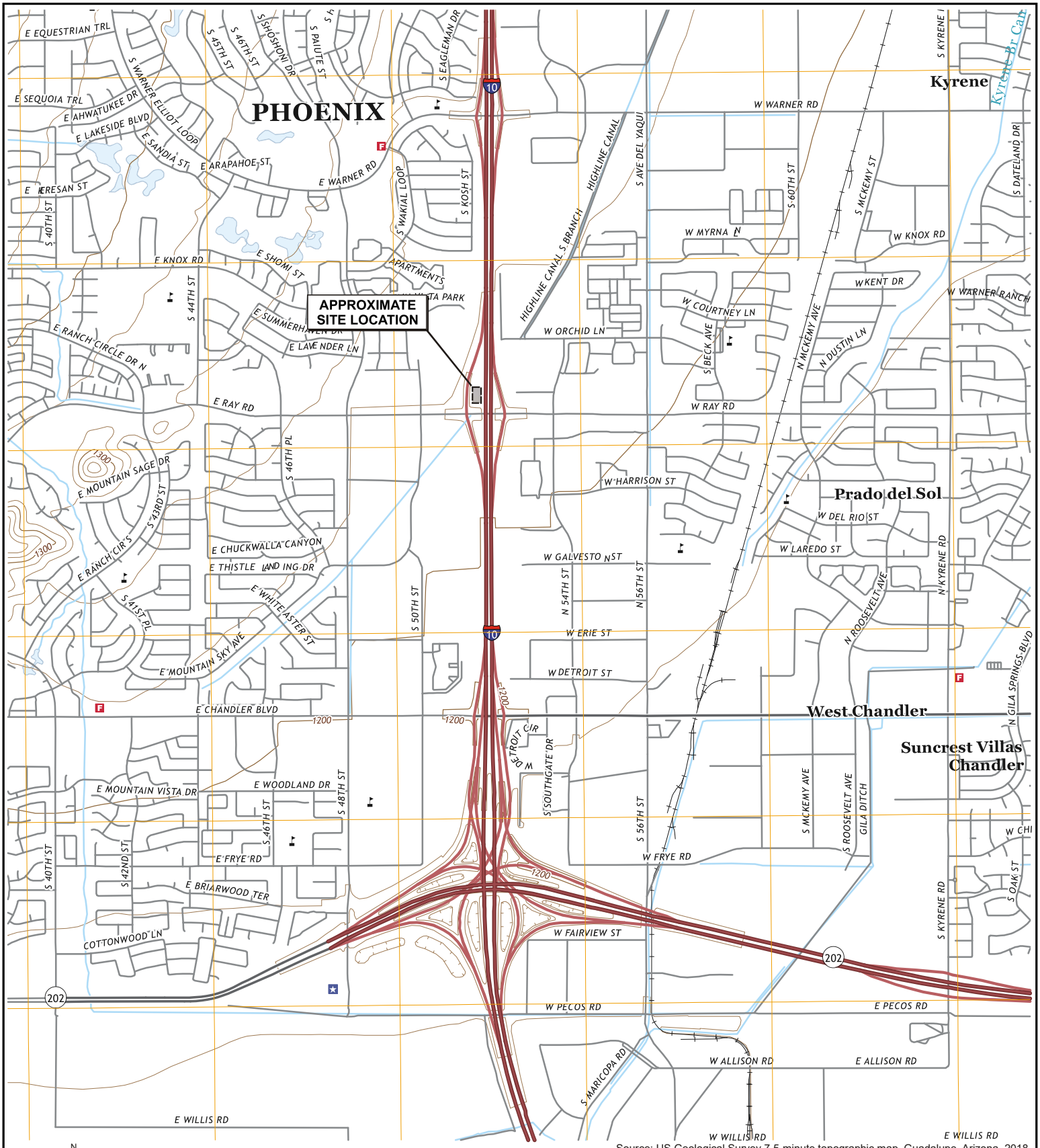
FIGURES



Source: US Geological Survey 7.5-minute topographic map, Guadalupe, Arizona, 2018.

N

FEET

0 2000

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

FIGURE 1

SITE LOCATION

LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

elt file no: 6504vmap0920

Source: NAVTEQ, 08/12/19.

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NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

FIGURE 2

BORING LOCATION

LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

Ninyo & Moore
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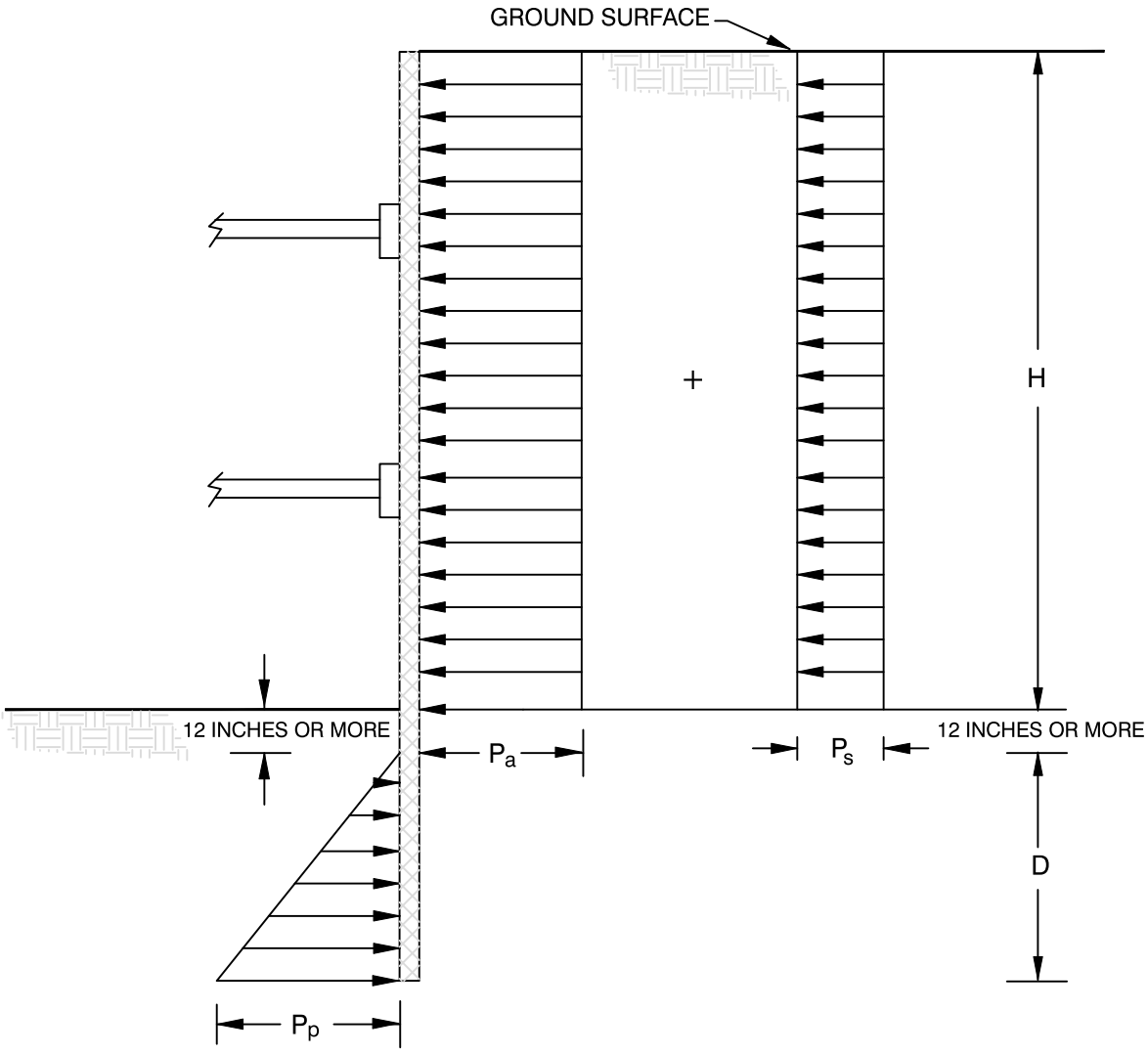
elt file no: 6504blm0920



NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_a
   P_a = 40 H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 360 D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

FIGURE 3

LATERAL EARTH PRESSURES FOR BRACED EXCAVATION

LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

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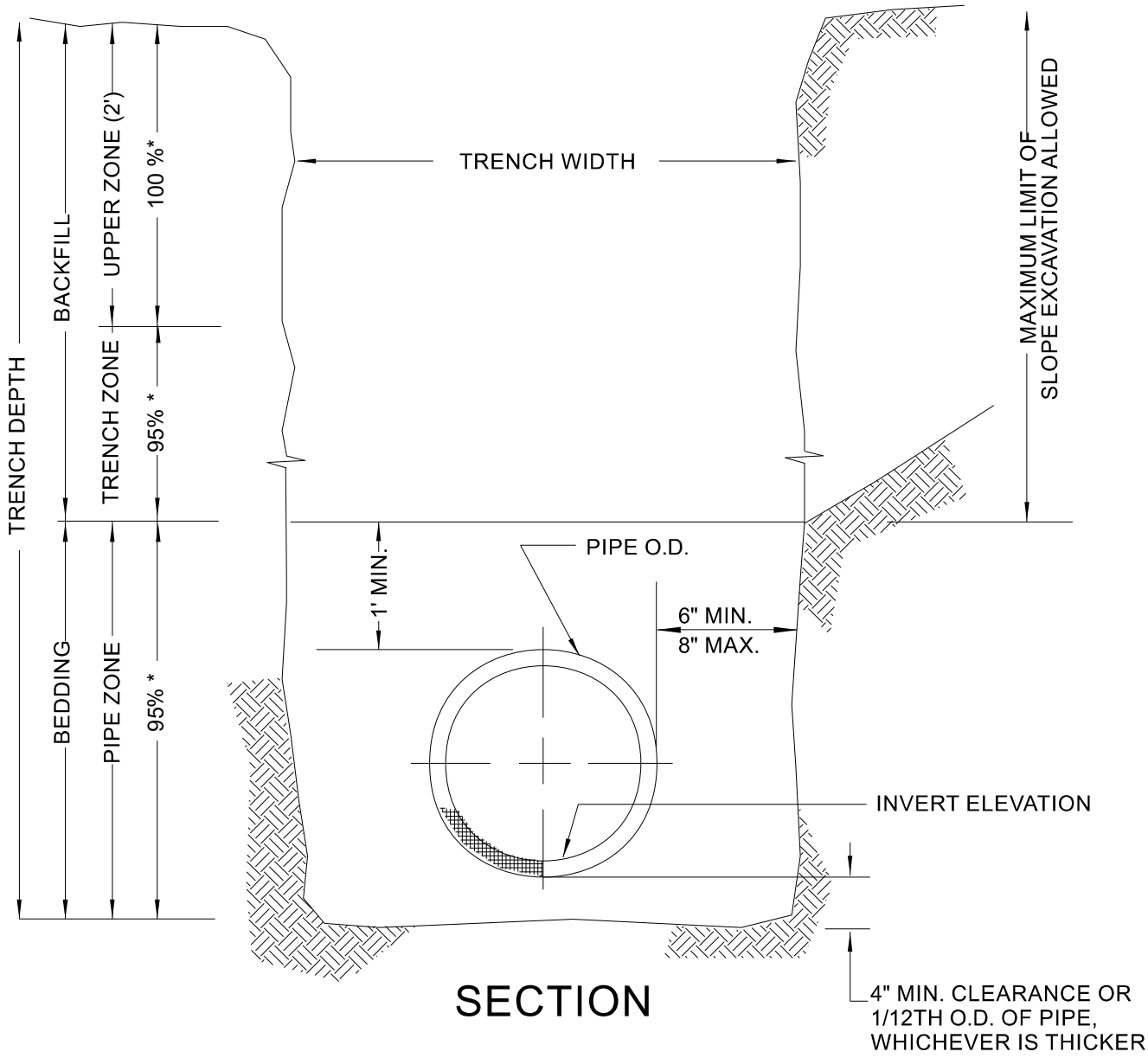

SECTION

NOTE

* Indicates minimum relative compaction (see report for details).

Upper zone required for pavement areas only.

Diagram not drawn to scale.

NOT TO SCALE

FIGURE 4

PIPE BEDDING GUIDELINES

LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

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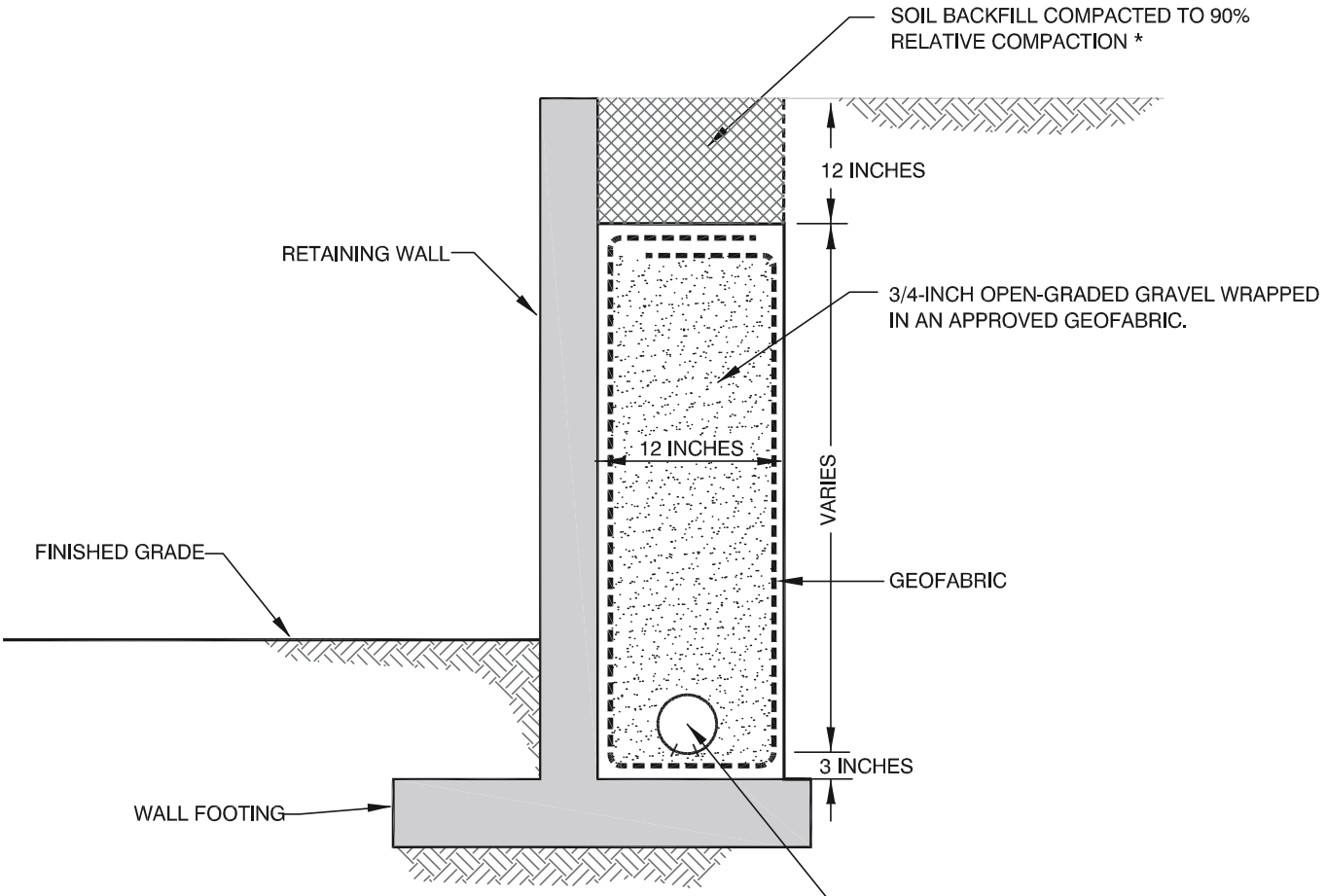

*BASED ON ASTM D1557

FIGURE 5

RETAINING WALL DRAINAGE DETAIL

LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

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Geotechnical & Environmental Sciences Consultants

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APPENDIX A

Boring Log

APPENDIX A

BORING LOG

Field Procedure for the Collection of Disturbed Samples
Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples
Bulk samples of representative earth materials were obtained from the exploratory boring. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler
Disturbed drive samples of earth materials were obtained by means of a SPT sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven up to 18 inches into the ground with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the log are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed, and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples
Relatively undisturbed soil samples were obtained in the field using the following method.

The Modified Split-Barrel Drive Sampler
The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D3550. The approximate length of the fall, the weight of the hammer or bar, and the number of blows per foot of driving are presented on the boring log as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

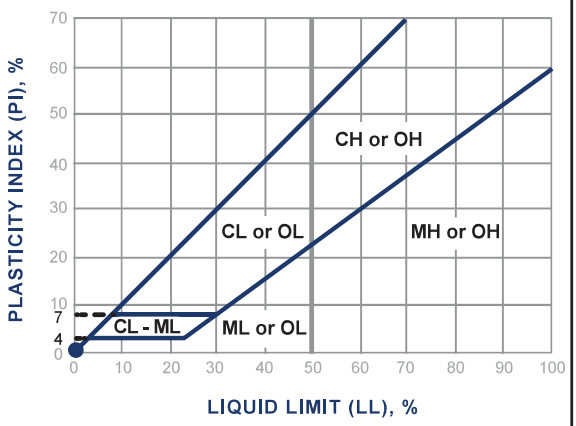
Soil Classification Chart Per ASTM D 2488

Primary Divisions			Secondary Divisions	
			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 4 sieve	**GRAVEL** more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	**SILT and CLAY** liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consis-tency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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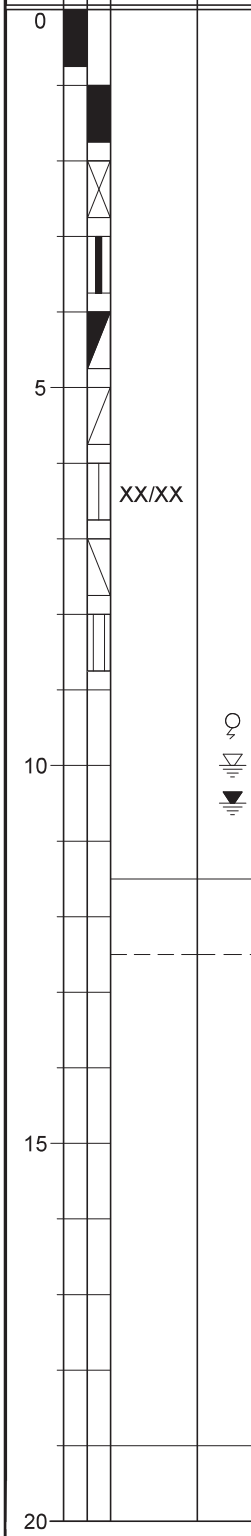
USCS METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET



Bulk sample.

Modified split-barrel drive sampler.

No recovery with modified split-barrel drive sampler.

Sample retained by others.

Standard Penetration Test (SPT).

No recovery with a SPT.

Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.

No recovery with Shelby tube sampler.

Continuous Push Sample.

Seepage.

Groundwater encountered during drilling.

Groundwater measured after drilling.

SM

MAJOR MATERIAL TYPE (SOIL):
Solid line denotes unit change.

CL

Dashed line denotes material change.

Attitudes: Strike/Dip
b: Bedding
c: Contact
j: Joint
f: Fracture
F: Fault
cs: Clay Seam
s: Shear
bss: Basal Slide Surface
sf: Shear Fracture
sz: Shear Zone
sbs: Shear Bedding Surface

The total depth line is a solid line that is drawn at the bottom of the boring.

DATE DRILLED 8/13/20 BORING NO. B-1

GROUND ELEVATION 1,230' ± (MSL) SHEET 1 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ASPHALT CONCRETE: Approximately 3 inches thick.
							AGGREGATE BASE: Approximately 6 inches thick.
		7				SC	FILL: Brown, dry, loose, clayey SAND.
		4					
5		14	8.1	112.4			Moist; trace gravel.
		36				SC	ALLUVIUM: Brown, moist, very dense, clayey SAND; scattered caliche nodules.
10		48	9.7	111.5			Dense.
15							
		21					
20							

FIGURE A- 1

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LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

DATE DRILLED 8/13/20 BORING NO. B-1

GROUND ELEVATION 1,230' ± (MSL) SHEET 2 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20						SC	ALLUVIUM: (Continued) Brown, moist, dense, clayey SAND; scattered caliche nodules.
		22	6.3	114.2			Medium dense.
25							
		19					
30							
		28					
35							
		22					Dense.
40							

FIGURE A- 2

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LIFT STATION 40 REFURBISHMENT
PHOENIX, ARIZONA

606504001 | 9/20

DATE DRILLED 8/13/20 BORING NO. B-1

GROUND ELEVATION 1,230' ± (MSL) SHEET 3 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40						SC	ALLUVIUM: (Continued) Brown, moist, dense, clayey SAND; scattered caliche nodules.
		33					Medium dense.
45							
		38					Very dense.
50							Total Depth = 50 feet. Groundwater not encountered during drilling. Backfilled and asphalt concrete patched on 8/13/20 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
55							
60							

APPENDIX B

Laboratory Testing

APPENDIX B

LABORATORY TESTING

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D2488. Soil classifications are indicated on the log of the exploratory boring in Appendix A.

In-Place Moisture and Density Tests
The moisture content and dry density of relatively undisturbed samples obtained from the exploratory boring were evaluated in general accordance with ASTM D2937. The test results are presented on the log of the exploratory boring in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D422. The grain-size distribution curves are shown on Figures B-1 and B-2. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

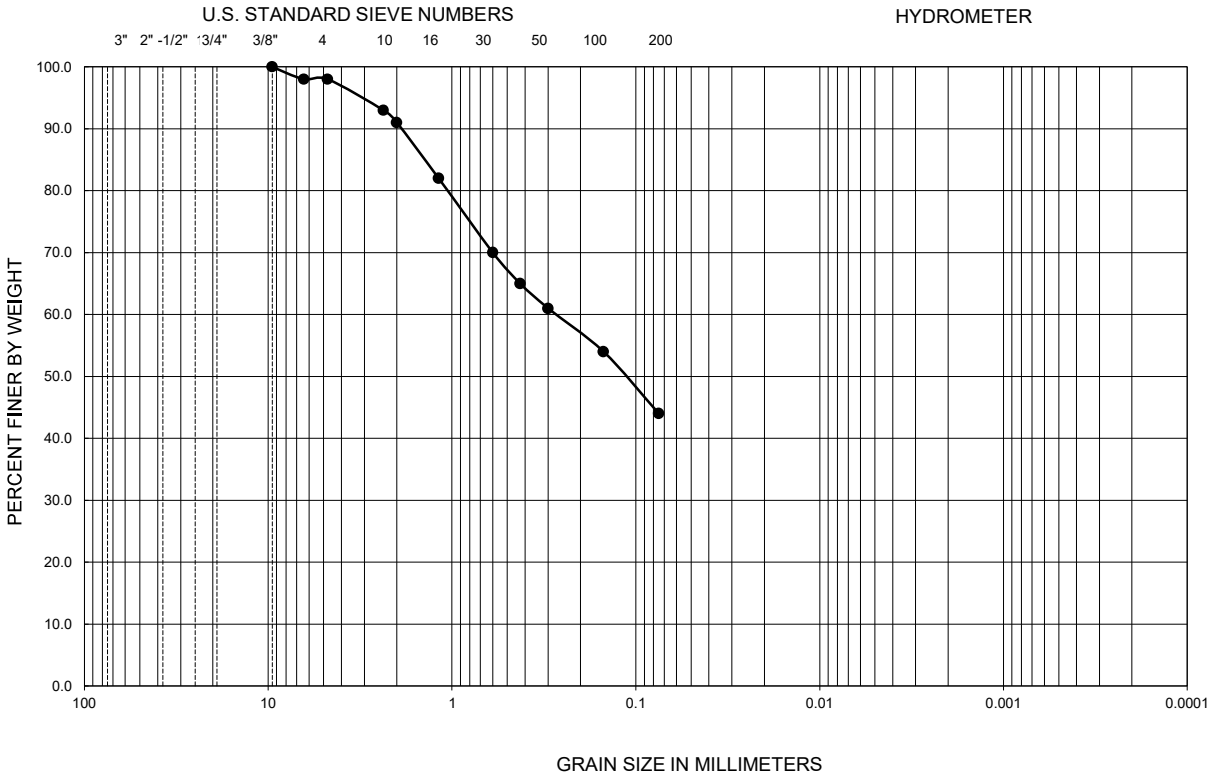
Atterberg Limits
Atterberg Limits Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-3.

Consolidation Tests
Consolidation tests were performed on selected relatively undisturbed soil samples in general accordance with ASTM D2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The results of the test are summarized on Figures B-4.

Direct Shear Tests
Direct shear test was performed on relatively undisturbed samples in general accordance with ASTM D3080 to evaluate the shear strength characteristics of selected materials. The sample was inundated during shearing to represent adverse field conditions. The results are shown on Figure B-5.

Soil Corrosivity Tests
Soil pH and minimum resistivity tests were performed on a representative sample in general accordance with Arizona test method, ARIZ 236c. The chloride content of the selected sample was evaluated in general accordance with ARIZ 736. The sulfate content of the selected sample was evaluated in general accordance with ARIZ 733. The test results are shown on Figure B-6.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-1	6.0-7.5	27	17	10	--	--	0.28	--	--	44.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-1

GRADATION TEST RESULTS

LIFT STATION 40 REFURBISHMENT

PHOENIX, ARIZONA

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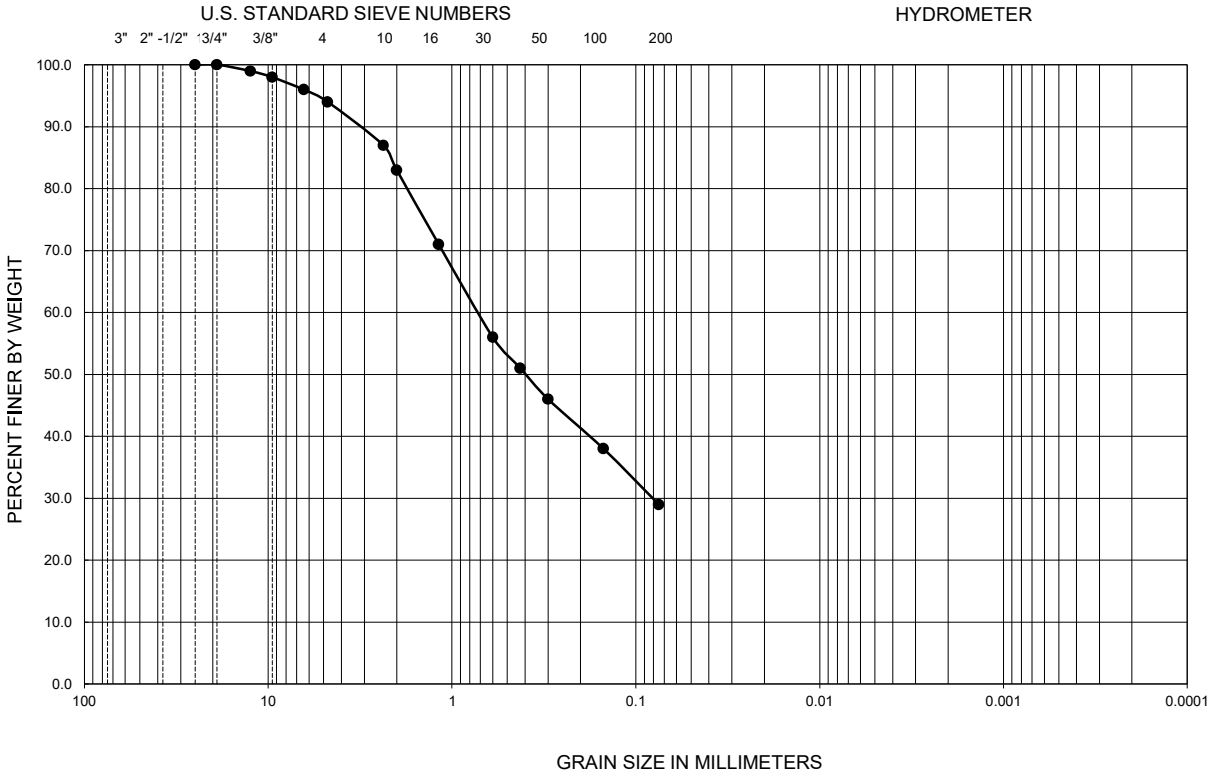
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-1	13.5-15.0	40	23	17	--	0.080	0.71	--	--	29.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-2

GRADATION TEST RESULTS

LIFT STATION 40 REFURBISHMENT

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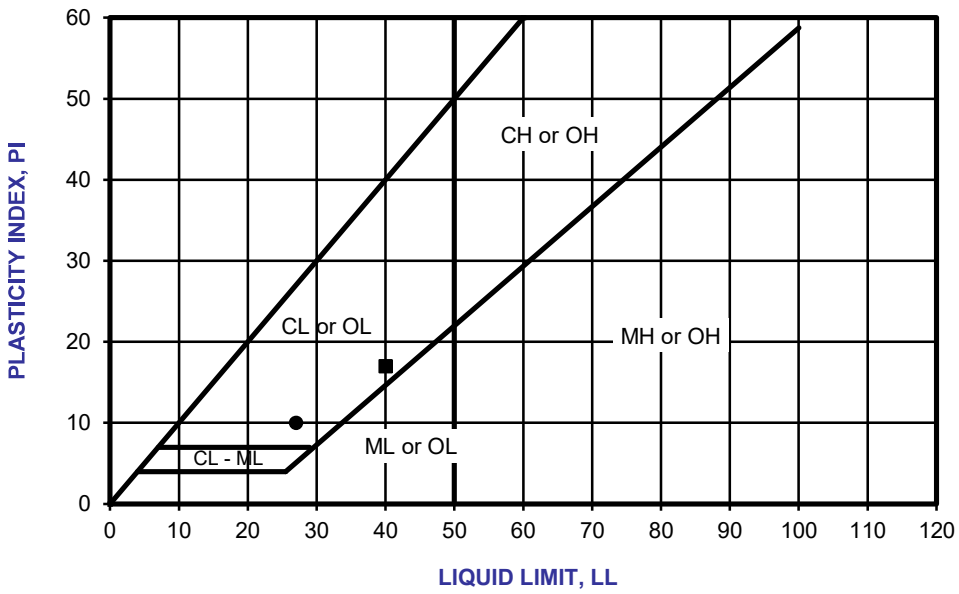
SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-1	6.0-7.5	27	17	10	CL	SC
■	B-1	13.5-15.0	40	23	17	CL	SC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

FIGURE B-3

ATTERBERG TEST RESULTS

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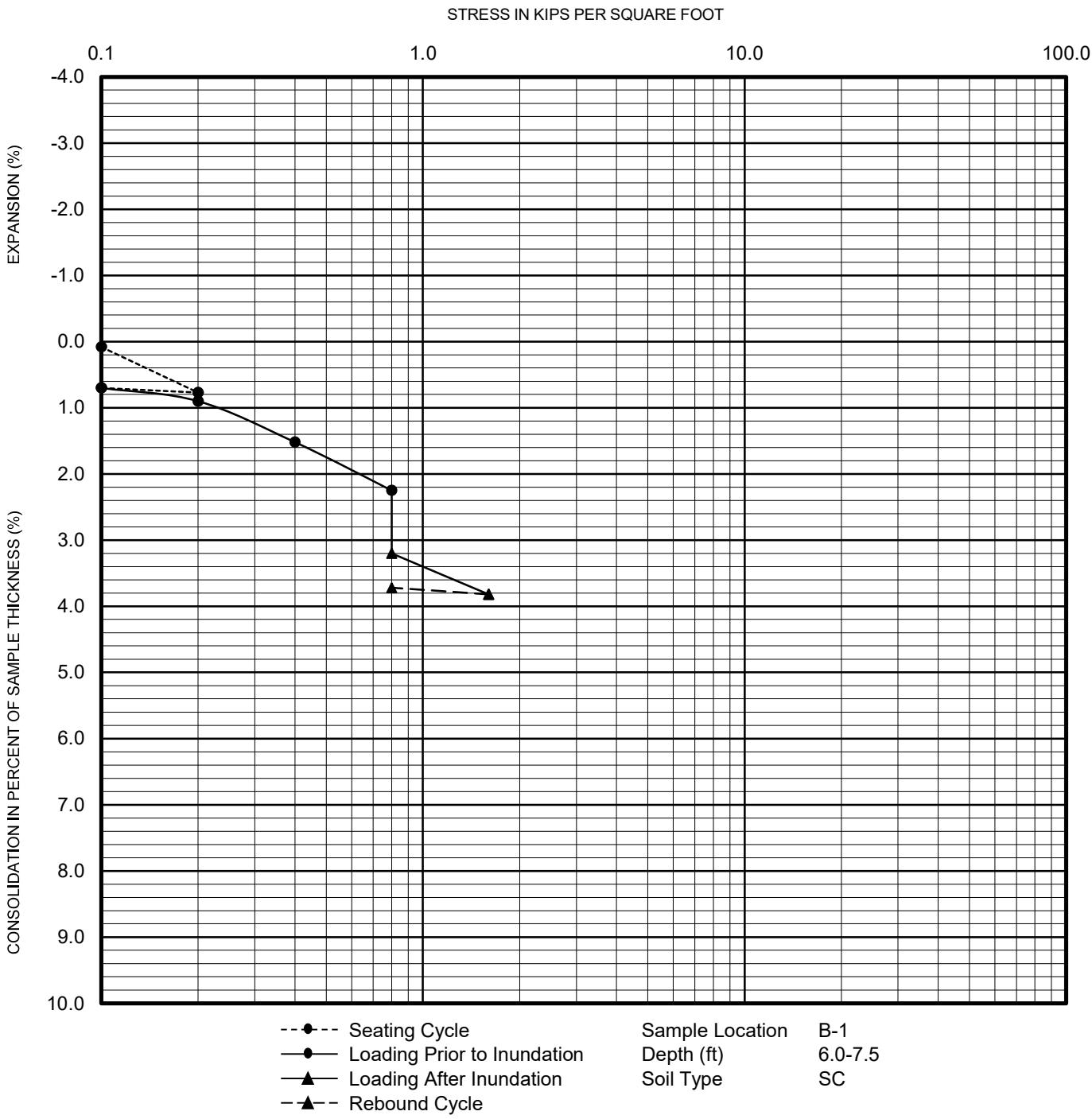

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435/4546

FIGURE B-4

CONSOLIDATION TEST RESULTS

LIFT STATION 40 REFURBISHMENT

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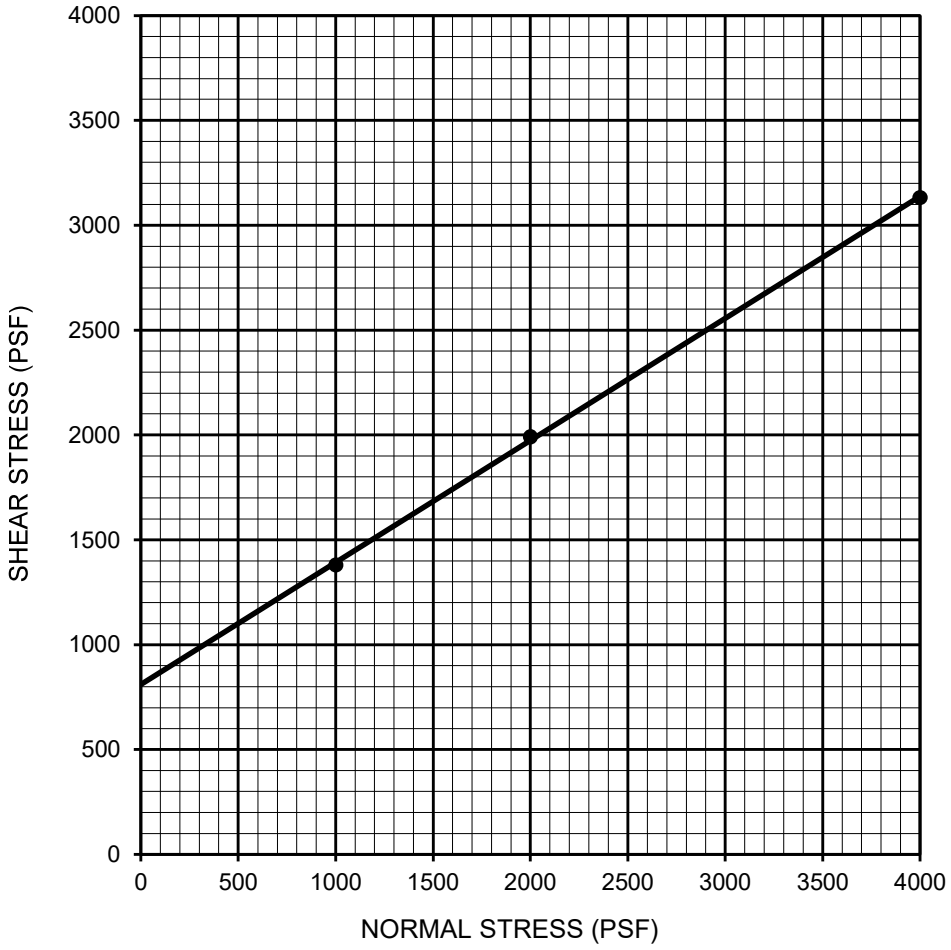

Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (degrees)	Soil Type
RELATIVELY UNDISTURBED	●—●	B-1	13.5-15.0	Peak	810	30	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

FIGURE B-5

DIRECT SHEAR TEST RESULTS

LIFT STATION 40 REFURBISHMENT

PHOENIX, ARIZONA

SAMPLE LOCATION	SAMPLE DEPTH (ft)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2] (ppm)	(%)	CHLORIDE CONTENT [3] (ppm)
B-1	1.0-5.0	7.9	3,551	24	0.002	6

[1] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236c
[2] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733
[3] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736

FIGURE B-6

CORROSIVITY TEST RESULTS

LIFT STATION 40 REFURBISHMENT

PHOENIX, ARIZONA

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SECTION 31 23 23.11

CRUSHED STONE, GRAVEL AND DECOMPOSED GRANITE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install crushed stone, gravel and decomposed granite of the types specified at locations shown on the Drawings and as directed by the ENGINEER.

1.2 QUALITY ASSURANCE

A. Conform to all applicable requirements of Section 701 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Government (MAG) as supplemented by the City of Phoenix. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and these Specifications, the provisions of these Specifications shall govern.

B. Sampling and sieve analysis shall be performed in accordance with ASTM D 75 and ASTM C 136.

1.3 SUBMITTALS

A. Submit for approval the following:
   1. Furnish representative samples of the crushed stone and gravel to the ENGINEER and advise of the source location.
   2. Test reports, including sieve analyses, showing material compliance with specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Furnish and place crushed stone or screened gravel fill under pipe or structures where shown on the Drawings in addition to that required under other Sections. Comply with requirements of Section 33 05 05, Buried Piping Installation.
   2. Crushed stone and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.
   3. The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C 131, Grading A, shall not exceed ten percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

B. Crushed Stone:
   1. Crushed stone shall consist of the product obtained by crushing rock, stone, or gravel so that at least 50 percent by weight of aggregate retained on the No. 4 sieve for 3/4-inch or larger maximum sizes, and 50 percent retained on the No. 8 sieve for maximum sizes less than 3/4-inch shall consist of particles which have at least one rough, angular surface produced by crushing.
   2. The gradation of crushed stone shall comply with ASTM D 448.

C. Gravel:
   1. Material designated herein as gravel shall be composed entirely of particles that are either fully or partially rounded and water-worn.
   2. Crushed rock obtained by crushing rock which exceeds ASTM D 448 maximum gradation sizes may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as stated in this specification.

D. Decomposed Granite:
   1. Decomposed granite shall be ¾-inch minus, supplied form a single supply source, for a uniform appearance throughout the Project. It shall be free from lumps or balls of clay and shall not contain any calcareous coatings, caliches, organic matter of foreign substances.

PART 3 - EXECUTION

3.1 PLACING

A. Gravel shall be spread in layers of uniform thickness not exceeding 8-inches and shall be thoroughly compacted with suitable power-driven tampers or other power driven equipment. The placing of crushed stone or gravel shall conform to applicable requirements of Section 31 23 00, Structural Excavation and Backfill, except as noted above.
B. Prior to placing decomposed granite, all areas to receive it shall be sprayed with a pre-emergent herbicide according to the manufacturer's recommendations within Maricopa Association of Governments (civil) requirements. Do not spray herbicide on any areas designated to receive seeding. Decomposed granite shall be rolled uniformly for depth and compacted to all areas designated on the DRAWINGS to a minimum depth of 2 – inches.

+ + END OF SECTION + +

SECTION 32 12 00

BITUMINOUS PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install hot mix hot-laid bituminous paving.
   2. The Work includes the following:
      a. Preparation of subgrade.
      b. Coarse graded base course.
      c. Fine graded surface course.
      d. Pavement marking.
      e. Testing as specified.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of the Uniform Standard Specifications For Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix as follows:
      a. Section 321, Asphalt Concrete Pavement.
      b. Section 702, Base Materials.
      c. Section 703, Emulsified Asphalts.
      d. Section 710, Asphalt Concrete.
   2. If there is a conflict between the MAG Standard Specifications as supplemented by the City of Phoenix and these Specifications, the provisions of these Specifications shall govern.

   3. City of Phoenix, Streets and Traffic Department Standard Specifications.
      a. S.S.P-2 - Water-Bourne Traffic Binder Paint.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, unless otherwise shown or specified.
   1. ASTM C 117, Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates By Washing.
   2. ASTM C 136, Test Method for Sieve Analysis of Fine And Coarse Aggregates.
   3. ASTM D 698, Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft^3).
   4. MAG Standard Specifications, Section 321, as supplemented by the City of Phoenix.
   5. MAG Standard Specifications, Section 702, as supplemented by the City of Phoenix.
   6. MAG Standard Specifications, Section 710, as supplemented by the City of Phoenix.

7. Standard Specification S.S.P.-2, City of Phoenix Streets and Traffic Department.

C. Testing Services:
   1. General: Testing of materials and of compaction requirements for compliance with technical requirements of the Specifications shall be the duty of a testing laboratory provided by the CONTRACTOR, as described in Section 01 45 29.20, Testing Laboratory Services Furnished by CONTRACTOR . Determination and testing of the proposed design mix for the hot-mix course shall be performed by a testing laboratory provided by CONTRACTOR, as described in Section 01 45 29.20, Testing Laboratory Services Furnished by CONTRACTOR.
   2. Testing Services: The OWNER'S testing laboratory shall:
      a. Test CONTRACTOR'S proposed materials in the laboratory and field for compliance with the requirements of these Specifications.
      b. Perform field density tests to assure that the specified compaction of base course materials has been obtained.
      c. Report all test results to the ENGINEER and CONTRACTOR.
   3. Authority and Duties of OWNER'S Testing Laboratory: Technicians representing the testing laboratory shall inspect the materials in the field and perform compaction tests, and shall report their findings to the ENGINEER and CONTRACTOR. When the materials furnished or Work performed by the CONTRACTOR fails to fulfill Specifications requirements, the technician shall direct the attention of the ENGINEER and CONTRACTOR to such failure.
      a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Specifications, nor to approve or accept any portion of the Work.
   4. Responsibilities and Duties of CONTRACTOR: The use of testing services shall in no way relieve CONTRACTOR of his responsibility to furnish materials and construction in full compliance with the Contract Documents. To facilitate testing services:
      a. Secure and deliver to the ENGINEER and the testing laboratory representative samples of the materials he proposes to use and which are required to be tested.
      b. Furnish such casual labor as is necessary to obtain and handle samples at the project or at other sources of material.
      c. Advise the testing laboratory and ENGINEER sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

D. Pre-Paving Meeting:
   1. Prior to the placement of Bituminous Paving, arrange a meeting at the job-site with the paver and its foreman, general CONTRACTOR and its foreman, ENGINEER and other representatives directly concerned with placement. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending.

Review foreseeable methods and procedures relating to the paving work, including but not necessarily limited to, the following:

a. Review Project requirements, including Contract Documents, Project Schedule, approved Shop Drawings, pending and approved Change Orders and requests for information that may have been submitted by CONTRACTOR to ENGINEER.
b. Review required samples, submittals, and documentation procedures.
c. Review sub grade preparation
d. Review availability of materials, tradesman, equipment and facilities needed to make progress, avoid delays and protect the Work from damaging conditions.
e. Review required inspection, testing, certifying and quality control procedures.
f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. City of Phoenix Type C-3/4-inch Low Volume Traffic mix, giving complete data on materials, including source, location, percentages, temperatures and all other pertinent data.
   2. The submittal shall be reviewed by the ENGINEER and OWNER.

B. Material Certificates:
   1. In lieu of laboratory reports required in the State Standards, CONTRACTOR may submit certificates of compliance for the following:
      a. Coarse and fine aggregates from each material source and each required grading.
      b. Asphalt for each penetration grade.
      c. Job-mix design mixtures for each material or grade.
      d. Density of uncompacted bituminous concrete.
      e. Density of compacted bituminous concrete.
      f. Density and voids analysis for each series of bituminous concrete mixture test specimens.
      g. Bituminous concrete plant inspection.
   2. Certificates that materials, mixtures and plant comply with Specification requirements.
   3. Certificates signed by CONTRACTOR.

1.4 JOB CONDITIONS

A. Weather Limitations:
   1. For base paving 2-inches thick or greater, atmospheric temperature shall be 40°F and rising. For surface paving or pavement less than 2-inches thick, the surface temperature shall be 50°F or greater.
   2. No asphalt concrete shall be placed when the weather is foggy or rainy, or when the base on which the material is to be placed contains moisture in excess of the optimum. Asphalt concrete shall be placed only when the ENGINEER deter-mines that weather conditions are suitable.

B. Grade Control: Establish and maintain the required lines and grades, including crown and cross-slope for each course during construction operations.

PART 2 - PRODUCTS

2.1 PAVEMENT THICKNESS

A. Provide a minimum of 2-inch compacted premixed base course and minimum of 2.0-inch compacted surface course for a total compacted depth of 4.0-inches or according to thickness detailed on the Drawings for pavement where shown on the Drawings.
B. All sides of the asphalt area shall be curbed flush with edge of asphalt, unless otherwise shown on the drawings, to retain the asphalt during placement and protect edges from damage by heavy equipment.

2.2 MATERIALS

A. Base Course:
   1. Base course material shall be a 1/2-inch hot mix asphalt concrete, consisting of a mixture of mineral aggregate and paving asphalt conforming to Section 710 of the MAG Standard Specifications. Gradation of the aggregate shall comply with the City of Phoenix Type C-3/4-inch Low Volume Traffic.
   2. The City of Phoenix Type C-3/4-inch Low Volume Traffic and A-1/2-inch asphalt shall contain a minimum of 1.5 percent cement and 5.5 percent oil.

B. Surface Course:
   1. Surface course material shall be a 1/2-inch hot mix asphalt concrete, consisting of mineral aggregate and paving asphalt conforming to Section 710 of the MAG Specifications. Gradation of the aggregate shall comply with the City of Phoenix Type C-3/4-inch Low Volume Traffic.
   2. The City of Phoenix Type C-3/4-inch Low Volume Traffic and A-1/2-inch asphalt shall contain a minimum of 1.5 percent cement and 5.5 percent oil.

C. Tack Coat: The tack coat shall be emulsified asphalt Type SS-1h according to MAG 329, unless directed otherwise by the ENGINEER.

2.3 TRAFFIC AND PARKING MARKING MATERIALS

A. Traffic and parking marking materials shall be a water based paint conforming to the City of Phoenix Streets and Traffic Department Operations Division Specification S.S.P-2, Water-Bourne Traffic Binder Paint. Refer to paragraph 1.2.A.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the subgrade on which bituminous concrete will be installed. Notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion

of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. No materials shall be placed on subgrades, which are muddy or have water thereon.

3.2 CONSTRUCTION OF ROADWAYS

A. General:
1. The pavement for bituminous-surfaced roads and parking areas shall consist of a 2-inch base course composed of aggregates and bituminous material, mixed hot in a central plant, and constructed on an aggregate base course prime coated with a rapid curing paving asphalt. A 2-inch surface course shall also be applied where shown on the Drawings.
2. The roadways shall be constructed to the lines, grades, and typical sections shown on the Drawings.

B. Base and Surface Course:
1. The base course mixture shall be transported to the site of paving and placed as soon as possible after mixing.
2. The placement of the base course shall be completed over the full width of the section under construction on each day's run.
3. Asphalt base and surface courses shall be spread and finished by means of self-propelled mechanical spreading and finishing equipment. The compacted thickness of layers placed shall not exceed 150 percent of the specified thickness except as approved, in writing, by the ENGINEER.
4. Sufficient rolling equipment shall be furnished to satisfactorily compact and finish the amount of mixture being placed. However, there shall be a minimum of two rollers with two operators on the Project at all times. Upon direction of the ENGINEER, one of the rollers may be a pneumatic-tire roller. During rolling operations, the speed of the roller(s) shall not exceed three miles per hour. If ample number of rollers are not present, adjust the asphalt placement rate to accommodate the roller(s) speed. The type and required number of rollers shall be on the Project and in acceptable operating condition, prior to the placement of any asphalt material. All rollers shall be operated continuously from the breakdown through finish rolling. CONTRACTOR may use vibratory rollers in lieu of the steel-wheeled roller, however when the thickness of the asphalt is 1-inch or less, all rolling will be done in the static mode.
5. When more than one width of asphalt concrete material will be placed, a 6-inch strip adjacent to the area on which future material is to be laid shall not be rolled until such material has been placed but shall not be left unrolled more than two hours after being placed, unless the 6-inch unrolled strip is first heated with a joint heater. After the first strip or width has been compacted, the second width shall be placed, finished and compacted as provided for the first width, except that rolling shall be extended to include the 6-inches of the first width not previously completed.
6. At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers and finished, where necessary, with a hot smoothing iron to provide a uniform and smooth layer over the entire area compacted in this manner.
7. Breakdown rolling shall begin as soon as the mixture will bear the roller without undue displacement. Rolling shall be longitudinal, overlapping on successive

trips by at least 1/2 but not more than 3/4 the width of the rear wheels. Alternate trips of the roller shall be of slightly different lengths. The motion of the roller shall at all time be slow enough to avoid displacement of the mixture. Finish rolling shall be done by means of a steel-wheeled roller or a vibratory steel-wheel roller operating in the static mode.

C. Tack Coat:
   1. A tack coat shall be applied to all existing and to each new course of bituminous surfaces prior to the placing of a succeeding layer of bituminous mixed material. The tack coat may be deleted when a succeeding layer of asphalt concrete is being applied over a freshly laid course that has been subjected to very little traffic when approved by the ENGINEER.
   2. The same material that is specified above for the tack coat shall be applied to the vertical surfaces of existing pavements, curbs, and gutters, against which asphalt concrete is to be placed.
   3. Tack coat shall be diluted in the proportion of 50 percent emulsion and applied at the rate of 0.05 to 0.10 gallons per square yard. Application shall be made in advance of subsequent construction as directed by the ENGINEER.
   4. Tack coat shall be applied by pressure-type distributor trucks with insulated tanks. Hand spray by means of hose or bar through a gear pump or air tank shall be acceptable for resurface work, corners or tacking of vertical edges. Care shall be taken to provide uniform coverage. Equipment that performs unsatisfactory shall be removed from the job.

D. Construction Joints:
   1. Construction joints shall be made in such a manner as to ensure a neat junction, thorough compaction and bond throughout.
   2. A transverse joint extending over the full width of the strip being laid and at right angles to its centerline shall be constructed at the end of each day's work and at any other times when the operations of placing the hot mixture are suspended for a period of time which will permit the mixture to chill. The forward end of a freshly laid strip shall be thoroughly compacted by rolling before the mixture has become chilled. When Work is resumed, the end shall be cut vertically for the full depth of the layer.

E. Joining of Pavements: When pavement is to join existing or previously laid pavement, the existing or previously laid pavement shall be neatly and carefully edged to allow for overlapping and feathering of the surface course material. A tack coat of bituminous prime coat material shall be placed at the interface of pavement and existing or previously laid pavement.

F. Curing: The pavement shall not be opened to traffic until directed by the ENGINEER. Construction traffic on the pavement shall be held to a minimum as allowed by the ENGINEER.

3.3 FRAME ADJUSTMENT

A. Set frames to final grade in an approved manner. Include existing frames and frames furnished under other Sections of these Specifications.

3.4 PAVEMENT QUALITY REQUIREMENTS

A. General: In addition to other specified conditions, comply with the following minimum requirements:
   1. Provide final surfaces of uniform texture, conforming to required grades and cross sections.
   2. Take not less than one 4-inch diameter pavement specimen for each complete course for each 10,000 square feet of pavement, unless directed by ENGINEER.
   3. Repair holes from test specimens as specified for patching defective Work.

B. Density:
   1. If directed by ENGINEER, compare density of in-place material against laboratory specimen or certificates on same bituminous concrete mixture. Use nuclear devices.
   2. Minimum acceptable density of in-place course material shall be 90 percent of the recorded laboratory specimen or certificate density. Maximum acceptable density shall be 98 percent.

C. Thickness: In-place compacted thicknesses shall average not less than the thicknesses specified.

D. Surface Smoothness:
   1. Test finished surface of each bituminous concrete course for smoothness, using a ten foot straightedge applied parallel to and at right angles to centerline of paved areas.
   2. Check surfaced areas at intervals as directed by ENGINEER.
   3. Surfaces will not be acceptable if exceeding the following:
      a. Base Course: 3/8-inch in ten feet.
      b. Surface Course: 1/4-inch in ten feet.
      c. Crowned Surfaces:
         1) Test crowned surfaces with a crown template, centered and at right angles to the crown.
         2) Surfaces will not be acceptable if varying more than 1/4-inch from the template.

3.5 PATCHING

A. As directed by ENGINEER, remove and replace all defective areas. Cut-out such areas and fill with fresh bituminous concrete. Compact to the required density.

3.6 CLEANING AND PROTECTION

A. Cleaning: After completion of paving operations, clean surfaces of excess or spilled bituminous materials and all foreign matter.

B. Protect newly finished pavement until it has become properly hardened by cooling.

C. Cover openings of drainage structures in the area of paving until permanent coverings are placed.

3.7 MARKING PAVEMENT

A. Cleaning:
   1. Sweep surface with power broom supplemented by hand brooms to remove loose material and dirt.
   2. Do not begin marking bituminous concrete pavement until approved by ENGINEER.

B. Application:
   1. Using mechanical equipment, provide uniform straight edges in two separate coats. Apply in accordance with paint manufacturer's recommended rates. Refer to paragraph 1.2.A.3.

CITY OF PHOENIX – 2002 APPROVED ASPHALT PLANTS AND MIX PRODUCT CODES

MIX **PLANTS**	A-1 1/2" 4.3% W/C (High Volume)	A-1 1/2" 4.8% W/C (High Volume)	C-3/4" 5.0% W/C (High Volume)	C-3/4" 5.5% W/C (High Volume)	D-1/2" 5.1% W/C (High Volume)	D-1/2" 5.6% W/C (High Volume)
Vulcan (All Plants)	814325	814825	835025	835525	845125	845625
New West Val Vista #152	25AP152	25RP152	19AP152	19RP152	12AP152	12RP152
New West Sun City #302	25AP302	25RP302	19AP302	19RP302	12AP302	12RP302
New West Avondale #402	25AP402	25RP402	19AP402	19RP402	12AP402	12RP402
Mesa – East #1	732	741	535	544	431	438
Mesa – Sun #2	732	741	535	544	431	438
UM #10131 (01)	14301D	14801D	35001D	35501D	45101D	45601D
UM #10231 (02)	14302E	14801E	35001E	35501E	45101E	45601E
UM #11131 (11)	14301A	14801A	35004A	35504A	45103A	45601A
UM #11231 (12)	14302B	14801B	35003B	35504B	45101B	45602B
UM #14131 (41)	14301J	14801J	35002J	35504J	54101J	45601J

+ + END OF SECTION + +

SECTION 32 31 00

FENCES AND GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as required to furnish and install fencing Work as shown on the Drawings and as specified.
   2. Extent of fencing Work is shown on the Drawings and specified herein.
   3. Types of products required include the following:
      a. Aluminum-coated, steel chain-link fabric.
      b. Galvanized steel framework.
      c. Polyvinylchloride fusion bonded finish.
      d. Gate operators and control systems.
      e. Razor ribbon.
      f. Grounding and bonding.
      g. Auxiliary system components, gates, accessories, fasteners and fittings, and locks.

1.2 QUALITY ASSURANCE

A. Erector Qualifications:
   1. Engage a single erector skilled, trained and with successful and documented experience, minimum five years, in the installation of fencing, and who is acceptable to the fencing manufacturer. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owner, architects or engineers responsible for projects.
      b. Approximate contract cost of the fencing.
      c. Amount of area installed.

B. Reference Standards. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM A 53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   2. ASTM A 90, Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
   3. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. ASTM A 428, Test Method for Weight of Coating on Aluminum-Coated Iron or Steel Articles.
   6. ASTM A 491, Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.

7. ASTM A 570, Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
8. ASTM A 585, Specification for Aluminum-Coated Steel Barbed Wire.
9. ASTM A 653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM A 780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
11. ASTM A 817, Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric.
12. ASTM A 824, Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
13. ASTM B 6, Specification for Zinc.
14. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
15. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
16. ASTM D 792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
17. ASTM D 1499, Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics.
18. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
19. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
20. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
21. ASTM F 552, Terminology Relating to Chain Link Fencing.
22. ASTM F 567, Practice for Installation of Chain-Link Fence.
23. ASTM F 626, Specification for Fence Fittings.
24. ASTM F 668, Specification for Poly(Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric.
25. ASTM F 900, Specification for Industrial and Commercial Swing Gates.
26. ASTM F 1043, Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
27. ASTM F 1083, Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
28. ASTM F 1184 - Specification for Industrial and Commercial Horizontal Slide Gates.
29. ASTM F 1664, Specification for Poly(Vinyl Chloride)(PVC)-Coated Steel Tension Wire Used With Chain-Link Fence.
30. ASTM F 1665, Specification for Poly (Vinyl Chloride)(PVC)-Coated Steel Barbed Wire Used With Chain-Link Fence.
31. ASTM G 23, Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials.
32. Institute of Electrical and Electronic Engineers (IEEE), C2 - National Electrical Safety Code.
33. Institute of Electrical and Electronic Engineers (IEEE), 81 - Standard Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
34. National Electrical Manufacturers Association, NEMA ICS 1, Industrial Control and Systems: General Requirements.

35. National Electrical Manufacturers Association, NEMA ICS 2, Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
36. National Electrical Manufacturers Association, NEMA ICS 6, Industrial Control and Systems: Enclosures.
37. National Electrical Manufacturers Association, NEMA MG 1, Motors and Generators.
38. Chain Link Fence Manufacturer's Institute (CLFMI), CLF 2445 - Product Manual.
39. Underwriters' Laboratories, Incorporated, Standards for Safety, UL 467, Grounding and Bonding Equipment.
40. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).
41. Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments.

C. Testing Agency Qualifications: To qualify for approval, an independent testing agency shall demonstrate to ENGINEER'S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work, in accordance with ASTM E 329 and as documented according to ASTM E 548.

D. Source Quality Control:
   1. Provide fencing as a complete system with all gates, hardware, appurtenances and other components produced by a single manufacturer, including custom erection accessories, fittings, clamps and fastenings as may be necessary or required. Provide electrical, communication, security, surveillance, gate operators, components, devices and accessories from a single manufacturer regularly engaged in the manufacture of such items, acceptable to, and coordinated by, fencing manufacturer as part of fencing manufacturer's Shop Drawing submittal.
   2. Provide fence fabric imprinted with manufacturer's trade name, core wire gauge, and finished outside diameter gauge.
   3. Provide shipping list for materials used, endorsed with the manufacturer's voucher certifying that the material used in the fencing complies with this Section and with specific selections made on approved Shop Drawings.
   4. Structural shapes of satisfactory sections and equal strengths may be substituted if approved by ENGINEER.
   5. Electrical Components, Devices, and Accessories: Listed and labeled by a testing agency acceptable to the OWNER, and marked for intended use.
      a. Comply with requirements of the OWNER for automatic gate operators serving as a required means of access.

E. Performance Criteria:
   1. Comply with the standards of the Chain Link Fence Manufacturer's Institute for product and installation requirements and the requirements of ASTM F 567. These standards shall represent a minimum level of quality when additional information is not shown on the Drawings or specified in the Contract Documents.

2. The requirements of this Section shall conform to MAG Standard Specifications 420, 771 and 772, except as modified, added to, or changed herein. Where there is a conflict between MAG Standard Specification and this Section, the provision of this Section shall apply.
3. Where proposed fencing framework or other structural components varies from Contract Documents, the fabricator shall provide structural calculations for the design of the proposed fencing to CONTRACTOR for submittal to ENGINEER as part of Shop Drawing review. Structural analysis shall verify that all system components including, but not limited to, supports, gates, fasteners, fittings and connections meet the requirements of the OWNER. Such modifications shall be incorporated into the Work only as acceptable to ENGINEER.
4. Verify size of framing members shown on the Drawings or specified, and submit with Shop Drawings. Member sizes, thicknesses and weights shown on the Drawings or specified shall be considered minimum. Where structural analysis indicates, provide additional members, or increased member size, thickness or weight.
5. Modifications may be made only as necessary to meet site conditions to ensure proper fitting and support of the Work, and only upon submittal of Shop Drawings and receipt of approval by ENGINEER.
6. Furnish weights of zinc and aluminum coatings on wire and pipe fabrications, in compliance with CLF 2445.
7. Furnish thickness of polyvinylchloride coating on wire and pipe fabrications, in compliance with CLF 2445.

F. Fabrication Tolerances:
1. Fabric, posts, rails, and other supports shall be straight or uniformly curved to provide the profiles shown on the Drawings, to a dimensional tolerance of 1/16-inch in ten feet without warp or rack in the finished installation.

G. Sample Mock-Ups:
1. Build a ten foot long full-height sample mock-up, incorporating all fencing materials specified for the Work at the site.
2. Demonstrate to ENGINEER the ability to match the quality of workmanship, methods of detailing, and tolerances shown on the Drawings and specified. Once approved, the sample mock-up shall serve as a standard for all fencing Work.
3. Full size sample mock-ups that, in the opinion of ENGINEER, do not adequately demonstrate the ability of the erector to provide the requirements specified will not be approved. Provide a proposed alternative erector to ENGINEER for approval.
4. Each manufacturer and erector proposed shall be permitted to build two full size sample mock-ups using approved components as required to obtain ENGINEER'S approval. If after building two mock-ups, ENGINEER is still uncertain that the manufacturer or erector is capable of matching the workmanship, methods of detailing and performance requirements specified, provide a proposed alternative manufacturers and erectors. Continue this process until the Work of an acceptable manufacturer and erector is approved.
5. Full size sample mock-up shall not be altered, moved or destroyed until written permission is received from ENGINEER. Mock-ups destroyed before

CONTRACTOR receives written permission shall be rebuilt, at no additional cost to OWNER.

6. Work advanced without an approved sample mock-up shall be stopped, and a sample mock-up prepared for ENGINEER'S approval.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each fencing component, fastener, post, rail, support, chain-link fabric and other auxiliary and miscellaneous items labeled with identification as to use and location.
   2. Each chain-link fabric material, 6-inches square; and framework members, and typical accessories, each approximately 6-inches long.
   3. Full range of manufacturer's standard and custom colors.
   4. ENGINEER'S review will be for color and texture only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical product information, specifications and installation instructions for all fencing components, and auxiliary system components such as gate operators and motors, security, radio controls, loop detectors, communications, and surveillance devices.
   2. Furnish gate operating instructions and motor manufacturer nameplate data, ratings, and other characteristics.
   3. All structural calculations verifying that all system components comply with the requirements of the Specifications.
   4. Large scale details drawn at a scale of 3-inches equals one foot for all connections and gate details, including motor mounting arrangements.
   5. Drawings at a scale of 1/4-inch equals one foot of typical fence assembly, identifying all materials, dimensions, sizes, weights, and finishes of all rails, posts, braces, supports and other fencing components. Show fence heights, and locations of gates. Show gate swing, or other operation, hardware, and accessories. Include plans, elevations, sections, with required installation and operating clearances, and details of post anchorage, attachments and bracing.
   6. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   7. Wiring Diagrams: Power and control wiring, communication and access control features. Differentiate between manufacturer-installed and site-instal-led wiring and between components provided by gate operator manufacturer and those provided by others.
   8. Qualifications Data: Submit qualifications data for the following:
      a. Erector.
      b. Test agency.
   9. A list of all hardware, fasteners and accessories.
   10. Maintenance Manual for Motorized Gate Operators and PVC Finish: Provide five copies of manufacturer's written instructions for recommended mainte-nance practices. Include the following information:
      a. Product name and number.

b. Name, address and telephone number of manufacturer and local distributor.
c. Detailed procedures for routine maintenance and cleaning.
d. Detailed procedures for repairs.

C. Test Reports: Submit the following:
1. Physical properties of polyvinylchloride protective coating in compliance with ASTM D 1499.
2. Weight of aluminum coating on wire fabrications in compliance with ASTM A 428.
3. Weight of zinc coating on pipe fabrications in compliance with ASTM A 90.
4. On-Site Test Reports: Indicate and interpret test results for compliance of chain-link fence and gate grounding and bonding with performance requirements.

D. Certificates: Submit the following:
1. Verification that gate operators comply with the OWNER'S requirements for safety and emergency access.
2. Verification that electrical components, devices, and accessories are listed and labeled by a testing agency acceptable to the OWNER and are marked for intended use.

1.4 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Packaging and marking shall comply with CLF 2445.
2. Deliver materials in manufacturer’s original, unopened packaging with all factory-applied tags, labels and other identifying information intact, legible and accurately representing material approved on Shop Drawings by ENGINEER.
3. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.
4. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Storage of Materials:
1. Store all materials under weatherproof cover, off the ground and away from other construction activities.
2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components of the fencing.

C. Handling of Materials:
1. Handle material in a manner that is in compliance with product institute standards and that will prevent damaging coatings.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by OWNER or others, unless permitted under the following conditions, and then only after

arranging to provide temporary utility services according to requirements indicated.

1. Notify ENGINEER not less than 7 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without ENGINEER'S written permission.

B. Site-Measurements: Take measurements at the site and verify layout information and dimensions for fencing and gates in relation to property surveys and existing conditions.

C. Do not begin installation and erection of the fencing until final grading is completed.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Special Warranties:
1. Furnish manufacturer's written ten year warranty against cracking and peeling of the vinyl coating, and rusting or corrosion of the metal.
2. Furnish manufacturer's written ten year warranty against rusting or corrosion of the metal.
3. Furnish manufacturer's written five-year warranty for gate operators.

1.7 MAINTENANCE

A. Extra Materials:
1. Furnish extra materials from the same manufactured lot as the materials installed.
2. Provide a minimum of five percent excess over the required amount of fencing components. Pack in cartons and store on the site where directed by the ENGINEER.

B. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened and undamaged containers and packages; with legible labels accurately representing contents of container or package, indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
1. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used for this Project, with calculations establishing quantity of extra materials to be furnished to OWNER.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Tube sizes specified are nominal outside dimension.
   2. Roll-formed section sizes are the nominal outside dimensions.
   3. Wire gauges shall conform to American Steel and Wire Company gage.
   4. Heat-form all arcs and chords before protective coatings are applied to metal.
   5. All sizes specified are given for uncoated metal. All protective coatings are in addition to specified metal dimensions, gages and sizes.

B. Chain-Link Fence Fabric:
   1. One-piece fabric widths, for fencing 12 feet and less in height, complying with CLFMI product requirements.
   2. Wire mesh shall be woven throughout in the form of approximately uniform square mesh with parallel sides and horizontal and vertical diagonals of approximately uniform dimensions, of size and gage specified and in compliance with ASTM A 817, Type 1, cold-drawn carbon steel wire with minimum breaking strength of 2,170 pounds and coated with aluminized finish, as specified. Fabric shall be recommended by the Chain Link Fence Manufacturer's Institute for heavy industrial usage.
   3. Provide fabric knuckled to eliminate exposure of sharp edges.
   4. Fabric Gage: Provide the following:
      a. No. 6-gage wires.
      a. No. 9-gage wires.
   5. Mesh Size: Provide the following:
      a. 2-inch mesh.
   6. The fabric shall be connected to the line posts with 6-gauge hot dip galvanized wire clips every 14-inches, to terminal, corner, and gate posts by using bars.
   7. The fabric shall be connected to stretcher bars using 11-gauge hog rings or tension bands every 24-inches.

2.2 FRAMEWORK

A. General: The following table is provided for the convenience of CONTRACTOR and provides actual OD and equivalent nominal NPS size and trade size of round members.

Actual OD (inches)	NPS Size (inches)	Trade Size (inches)
1.315	1	1-3/8
1.660	1-1/4	1-5/8
1.900	1-1/2	2
2.375	2	2-1/2
2.875	2-1/2	3
3.500	3	3-1/2
4.000	3-1/2	4
6.625	6	6-5/8
8.625	8	8-5/8

B. Pipe shall be commercial grade, plain end steel pipe with standard weight walls. Steel strip used in the manufacture of pipe shall be in compliance with ASTM F 1083, Schedule 40 pipe with minimum yield strength of 25,000 pounds per square inch and protected with zinc, as specified.

C. End, Corner, and Pull Posts: Provide end, corner, and pull posts of minimum sizes as follows:
   1. Over six feet fabric height:
      a. 2.875-inches OD pipe weighing 5.79-pounds per linear foot.
   2. Over eight feet fabric height:
      a. 3.50-inches OD pipe weighing 7.58-pounds per linear foot.

D. Line Posts: Provide line posts of the minimum sizes and weights as follows:
   1. Over six feet fabric height:
      a. 2.375-inches OD pipe weighing 3.65-pounds per linear foot.
   2. Over eight feet fabric height:
      a. 3.50-inches OD pipe; weight of 7.58-pounds per linear foot.

E. Gate Posts: Furnish gateposts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:
   1. Up to six feet wide:
      a. 2.875-inches OD pipe weighing 5.79-pounds per linear foot.
   2. Over six feet and up to 13 feet wide:
      a. 4-inches OD pipe weighing 9.11-pounds per linear foot.
   3. Over 13 feet and up to 18 feet wide:
      a. 6.625-inches OD pipe weighing 18.97-pounds per linear foot.
   4. Over 18 feet:
      a. 8.625-inches OD pipe weighing 28.55-pounds per linear foot.

F. Top Rail: Provide top rails, unless otherwise shown on the Drawings, of the following:
   1. 1.900-inch OD pipe weighing 2.72-pounds per linear foot.
   2. Provide in manufacturer's longest lengths, with expansion type coupling 0.051-inch thick rail sleeves, approximately 7-inches long, for each joint.
   3. Provide means for attaching the top rail securely to each gate, corner, pull, and end post.

G. Center Rails between Line Posts: Provide center rails between line posts where shown on the Drawings, consisting of 1.660-inch OD pipe weighing 2.27-pounds per linear foot.

H. Roll-Formed Steel: Provide rolled steel shapes produced from structural-quality steel conforming to ASTM A 570, Grade 45, with a minimum yield strength of 45,000 pounds per square inch. Protective coating system shall conform to ASTM F 1043, as specified.

I. Post Brace Assembly: Provide bracing assemblies at end and gateposts and at both sides of corner and pull posts, with the horizontal brace located at mid-height of the fabric.
   1. Use 1.900-inch OD pipe weighing 2.72-pounds per linear foot for horizontal brace and 3/8-inch diameter rod with turnbuckle for diagonal truss.

2.3 GATES

A. Swing gates shall comply with the requirements of ASTM F 900.

B. Sliding chain link gates shall comply with the requirements of ASTM F 1184.

C. Gate hinges shall be of the double clamping offset type. To hold the gate in the open or closed positions, provide each gate frame with a keeper that automatically engages a gate shoe set in concrete. Gates shall have a drop latch with provision for a padlock.
   1. Gate Hinges: Pressed or forged steel or malleable iron to suit gate size, non-lift-off type, 180 degree offset heavy-industrial hinges; one pair per leaf.
   2. Latch: Forked-type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
   3. Keeper: Provide a gate keeper for vehicle gates that automatically engages gate leaf and holds it in the open position until manually released.

D. Padlocks: Provide each gate with a heavy-duty bronze padlock and shackle chain as follows:
   1. Product and Manufacturer: Provide one of the following:
      a. No. 160DHM with 11/32-inch marine brass shackle by the Master Lock Company.
      b. Or equal.
   2. Provide three keys for each padlock. Where more than one gate is required for the same enclosure, padlocks shall be keyed the same.

E. All gate frames shall have intermediate horizontal rails. Gate frames shall be of welded construction and shall be galvanized after fabrication. Single gates six feet wide or wider and double gates 12-feet wide or wider shall be provided with diagonal bracing in one direction, extending from top to bottom rail.

F. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage a center drop rod or plunger bar. Include locking device and padlock eyes as an integral part of the latch, using one padlock for locking both gate leaves.

G. Fabricate gate perimeter frames of tubular members. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories. Space so that frame members are not more than eight feet apart. Fabricate as follows:
   1. Up to six feet high, or leaf width eight feet or less:
      a. 1.660-inch OD pipe weighing 2.27-pounds per linear foot.
   2. Over six feet high, or leaf width exceeding eight feet:
      a. 1.900-inch OD pipe weighing 2.72-pounds per linear foot.

H. Assemble gate frames by welding. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to gate frame at not more than 15-inches on center. Attach hardware with rivets or by other means which will provide security against removal or breakage.

I. Install diagonal cross-bracing on gates consisting of 1/2-inch diameter adjustable length truss rods provided with turnbuckles to ensure frame rigidity without sag or twist.

J. Where barbed wire or razor ribbon is shown on the Drawings above gates, extend the end members of gate frames 1’-0” above the top member and prepare to receive three strands of wire. Provide necessary clips for securing wire to extensions.

K. Sliding Gates: Provide manufacturer's heavy-duty track, ball-bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, and accessories as required.

2.4 GATE OPERATORS

A. Product and Manufacturer: Provide the following:
   1. Hy-Security Model Series 222.

B. General: Provide factory-assembled automatic gate operation system designed for gate size, type, weight, construction, use, traffic-flow patterns, and operation frequency. Provide operation system for gate specified and shown on the Drawings, of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended and provided by gate manufacturer complete with electric motor and factory pre-wired motor controls, remote-control stations, control devices, power disconnect switch, obstruction detection device, lockable weatherproof enclosures protecting controls and all operating parts, and accessories required for proper operation. Provide enclosures with corrosion--resistant-protective and decorative finish and two keys for each lock. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with Project electrical system.
   1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
   2. Provide operator in compliance with the OWNER'S requirements.
   3. Provide electronic components with built-in troubleshooting diagnostic feature.
   4. Provide units designed and wired for both right-hand/left-hand opening, permitting universal installation.

C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

D. Electromechanical Operation: Provide unit designed for concrete base/pad mounting; consisting of electric motor and factory pre-wired motor controls, starter, speed control device, brake, clutch or torque limiter, with enclosed worm gear reducer, wheel and rail drive.

E. Operation Cycle Requirements: Provide gate operator designed to operate for not less than the following duty and cycles per hour.
   1. Medium-Duty: Ten cycles per hour.
   1. Heavy-Duty: Twenty-five cycles per hour.
   1. Peak-Duty: Twenty cycles per hour at peak periods.
   1. 50 cycles per hour

F. Gate Operation Speed:
   1. 60 feet per minute, minimum.

G. Electric Motors: High-starting torque, reversible, continuous-duty, insulated electric motors, complying with NEMA MG 1, sized to start and operate size and weight of gate considering Project's service conditions, without exceeding nameplate ratings or considering service factor.
   1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   2. Enclosure: Totally enclosed, nonventilated or fan-cooled motors, fitted with plugged drain.
   3. Thermal Protection: Internal manual reset.
   4.
   5. Motors 1/2 hp and Larger: Polyphase, 208 vac, 60 Hz.

H. Remote Controls: Provide electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 4 enclosure for concrete base/pad mounting, and with space for additional optional equipment. Provide as indicated in the DRAWINGS and as specified below.
   2. Card Reader: As indicated on the DRAWINGS.

   6. Vehicle Loop Detector System: Provide a complete system including automatic closing timer with adjustable time delay before closing and loop detector designed to open and close gate and hold gate open until traffic clears. Provide electronic detector, with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on the Drawings, as recommended, in writing, by detection system manufacturer for function indicated.
      a. Loop: Wire, in size indicated for on-site assembly, and sealant; style for pave-over installation.
      a. Loop: Factory-preformed in size indicated; style for pave-over installation.

I. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor causes operator to immediately function as follows:
   1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
   2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
   3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity
      designed for type of gate and component indicated, located on gate as follows. Connect to control circuit using gate edge transmitter and operator receiver system.
      a. Along entire gate leaf leading edge.
      b. Along entire gate leaf trailing edge.
      c. Across entire gate leaf bottom edge.
      d. Along entire length of gate posts.

e. Along entire length of gate guide posts.

4. Photoelectric/Infrared Sensor System: Provide a complete system designed to detect an obstruction in gate leaf path by interruption of an infrared beam in the zone pattern without permitting obstruction to contact gate.

J. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

K. Emergency Release Mechanism: Quick disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Provide system configured such that control circuit power is disconnected during manual operation.
1. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.

L. Operating Features: Include the following:
1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability of monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
2. Fully Systems Compatible: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations configured and wired for gate pair operation.
4. Automatic Closing Timer: Provide circuitry with adjustable time delay before closing and with timer cut-off switch.
5. Open Override Circuit: Provide circuitry configured to override closing commands.
6. Reversal Time Delay: Provide time delay circuitry to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Configure circuitry to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: Seven-day programmable for regular events.

M. Operation pre-emption by City of Phoenix Fire Department:
1. The City of Phoenix approved Knox key switch shall be used for 24 hour Fire Department access. The emergency key switch, when activated, shall by-pass any occupant control and loop systems. When activated, the security gate will remain in the open position until deactivated by the Fire Department. Only when deactivated will the gate resume normal operation.
2. Pre-emption device shall be installed per City of Phoenix Fire Department installation requirements.

N. Accessories: Include the following:
1. Mounting kit including pedestal.
2. Audio Warning Module: Provide ADA-compliant audible alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
3. Visual Warning Module: Provide ADA-compliant visible light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.

4. UPS AC battery backup for systems up to 1 hp or VFD equipped. 208/230 VAC single phase only. 115 VAC single phase not available.
   External electric-powered lock with delay timer allowing time for lock to release before gate operates.
5. Fire box.
6. Instructional, Safety, and Warning labels and Signs: Manufacturer's standard for components and features specified in section 10 14 00 – Identification Signs.
7. APS “Lock Box”. Coordinate with Charles Thomas of the City of Phoenix. City of Phoenix to provide lock boxes for this project.
8. Fire: “Knox Key Switch”. Key Switch shall be provided for fire department use only. Contractor to provide switches for this project.

2.5 AUXILIARY FENCING MATERIALS AND ACCESSORIES

A. Wire Ties:
   1. For tying fabric to line posts, use 9-gage, aluminum alloy 1100-H4, polyvinylchloride coated wire ties to match fence fabric, spaced 12-inches on center.
   2. For tying fabric to rails and braces, use 9-gage, aluminum alloy 1100-H4, polyvinylchloride coated wire ties to match fence fabric, spaced 24-inches on center.
   3. For tying fabric to tension wire, use 11-gage, aluminum alloy 1100-H4, polyvinylchloride coated wire hog ring ties to match fence fabric, spaced 24-inches on center.

B. Tension Wire: Provide tension wire consisting of aluminized, 7-gage, coiled spring steel wire coated with 0.40-onces of aluminum per square foot of wire surface, minimum; in compliance with ASTM F1664.
   1. Locate at bottom of fabric only.
   1. Locate at bottom and top of fabric.

C. Barbed Wire Supporting Arms: Pressed steel for three rows of barbed wire attached to each arm, complete with provisions for anchorage to posts. Supporting arms shall be integral with post top weather cap. Provide following type:
   1. Single vertical arm, one for each post.
   1. Single 45 degree arm, one for each post.
   1. Vee-type with two arms, each at 45 degrees to vertical, one set for each post.
      a. Inverted Vee-type with two cross-braced arms, each at 45 degrees to vertical, one set for each post.

D. Barbed Wire: Commercial quality steel, three strand, two wires per strand, 11-gage line wire with 14-gage, 4-point twisted aluminum alloy barbs spaced 3-inches on center, as follows:
   1. PVC-coated, complying with ASTM F 1665.

E. Post Caps: Pressed steel, wrought iron, or cast aluminum alloy, designed as a weathertight closure cap, for tubular posts. Provide one cap for each post,

unless equal protection is afforded by combination post top cap and barbed wire supporting arm, where barbed wire is required.
1. Provide caps with openings to permit through passage of the top rail.
2. Provide cone-type caps for terminal posts and loop-type caps for line posts.

F. Stretcher Bars: One piece lengths equal to full height of fabric, with a minimum cross-section of 3/16-inch by 3/4-inch. Provide one stretcher bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into the post.

G. Stretcher Bar Bands: Pressed steel, hot dipped galvanized, 0.078-inches to 0.108-inches thick depending on post diameter, spaced not over 15-inches on center to secure stretcher bars to end, corner, pull, and gate posts.
1. Bands may also be used with special fittings for securing rails to end, corner, pull and gate posts.

H. Truss Rods: Steel rods, 3/8-inch diameter, merchant quality with turnbuckle.

I. Concrete: Refer to Section 03 30 00, Cast-In Place Concrete.

2.6 FENCE GROUNDING

A. Conductors: Bare, solid wire for No.6-gage and smaller; stranded wire for No. 4-gage and larger.
1. Material Above Finished Grade: Copper.
2. Material On or Below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30-gage bare copper wire, terminated with copper ferrules.

B. Connectors and Ground Rods: As listed in UL 467.
1. Connectors for Below-Grade Use: Exothermic welded type.
2. Ground Rods: Copper-clad steel.
a. Size: 5/8-inch by 8 feet-0 inches.

2.7 FINISHES

A. Chain-Link Fence Fabric:
1. Aluminized finish with not less than 0.40-ounces aluminum per square foot, complying with ASTM A 491, Class II.

B. Framework and Appurtenances: Provide the following finishes for steel framework, auxiliary system components and miscellaneous accessories:
1. Galvanizing: Zinc for galvanizing shall be of High Grade or Special High Grade conforming to ASTM B6 with a maximum aluminum content of 0.01 percent. Galvanize metal by the "hot-dip" process in compliance with the following standards:
a. Structural Iron and Steel Shapes, ASTM A 123.
b. Rolled-Form Sheet Steel, ASTM A 653.
c. Hardware and Accessories, ASTM A 153.
d. Fittings, ASTM F 626.
e. Pipe, ASTM A 53.

2. Provide minimum weights of zinc as follows:
   a. Pipe: 1.8-ounces of zinc per square foot. Type A coating shall be applied both inside and outside according to ASTM F 1043, as determined by ASTM A 90.
   b. Rolled-Form Sheet Steel: 4.0-ounces of zinc per square foot of surface area.
   c. Hardware and Accessories: Zinc weights in compliance with Table 1 of ASTM A 153.

C. PVC Finish for All Fencing Components: Provide polyvinylchloride (PVC) epoxy-modified plastic resin finish, fusion bonded to heated metal, minimum 10-mil thickness.
   1. Provide the following physical properties for polyvinylchloride coating:
      a. Specific Gravity, ASTM D 792: 1.30 to 1.38, maximum.
      b. Ultimate Tensile Strength, ASTM D 412: 2,600 pounds per square inch ±5 percent.
      c. Hardness, ASTM D 2240: Durometer A (Ten Second) 93 ±3.
      d. Ultimate Elongation, ASTM D 412: 275 percent ±5 percent.
      e. Compression Cut Resistance, Bell Laboratories: 2,000 pounds per square inch.
      f. Low Temperature Brittleness, ASTM D 746: -20°C.
      g. Low Temperature Flexibility, (Mandrel Wrap): -40°C.
      h. Weatherometer Exposure, ASTM G 23, with no change: 1,000 hours.
   2. Provide polyvinylchloride (PVC) plastic resin finish over aluminized steel wire by the thermal extrusion method, in compliance with ASTM F 668, Class 2b.
   3. Color:
      a. As selected by ENGINEER from manufacturer's complete range of standard and custom colors.
      b. Provide fencing with all components, including framework and accessories completely protected with color coating, in compliance with CLF 2445.

D. Welded Joints:
   1. Repair zinc coatings at welded joints by applying a zinc-rich paint, as specified in Section 09 90 00, Painting and Coating.
   2. Repair polymer-coated steel by applying an epoxy primer, intermediate coat and a urethane topcoat, as specified in Section 09 90 00, Painting, matching color and reflectivity of adjacent PVC finish.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the fencing and gates are to be erected and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Do not begin fence installation and erection before the final grading is completed with finish elevations established.

3.3 INSTALLATION AND ERECTION

A. Unless otherwise shown on the Drawings, install chain link fence system according to MAG Section 420.3.1, 420.3.2 and 420.3.3.

B. Excavation: Drill holes of diameters specified, for post footings in firm, undisturbed or compacted soil.
   1. For posts set in cast-in-place concrete, provide hole diameters dug or drilled a minimum of four times the largest cross section of the post.
      a. Unless otherwise shown on the Drawings, excavate hole depths approximately 3-inches lower than the post bottom, with bottom of posts set not less than 24-inches below the surface of finished grade when in firm, undisturbed soil, plus an additional 3-inches for each foot increase in the fence height over four feet.
      b. Excavate holes for sliding cantilever gateposts to not less than 3 foot-6 inches below grade and minimum diameter of 12-inches.
   2. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the site, as directed by the ENGINEER.
   3. When solid rock is encountered at the surface, drill into rock at least 12-inches for line posts and at least 18-inches for end, pull, corner, and gate posts. Drill hole at least 1-inch greater diameter than the largest dimension of the post to be placed.
      a. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed the minimum depths specified above.

C. Setting Posts: Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
   1. Center and align posts in holes 3-inches above bottom of excavation.
   2. Posts shall be set in concrete footings, except as otherwise shown on the Drawings or specified. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
   3. Extend concrete to 2-inches above grade or to 2-inches below grade if a cover of sod, blacktop, or other material is shown to conceal concrete. Crown to shed water away from posts.
   4. Extend footings for gate posts to the underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.
   5. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing materials, or other acceptable curing method.
   6. Grout posts set in sleeved holes, concrete constructions, or rock with grout, as specified in Section 03 60 00, Grouting, and as recommended by CLF 2445.

D. Concrete: Provide concrete consisting of Portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and clean water. Mix materials to

obtain concrete with a minimum 28-day compressive strength 2500 pounds per square inch, using at least four sacks of cement per cubic yard, 1-inch maximum size aggregate, maximum 3-inch slump, and 2-percent to 4-percent entrained air.

E. Concrete Strength: Allow concrete to attain at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than seven days after placement, before rails, tension wires, barbed wire, or chain-link fabric is installed.
   1. Do not stretch and tension fabric and wires, and do not hang gates until the concrete has attained its full design strength.

F. Posts and Rails:
   1. Line Posts: Set posts in cast-in-place concrete footings as specified, spaced not more than ten feet on centers. Install caps on tops of all posts to exclude moisture and to receive the top rail unless equal protection is afforded by combination post top cap and barbed wire supporting arm, where barbed wire is required.
   2. Top Rails: Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer to form a continuous rail between terminal posts.
   3. Center Rails: Provide center rails, where shown on the Drawings or specified, erected in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.
   4. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension. Install brace assemblies at end posts and at both sides of corner and pull post panels. Panels adjacent to gates shall have intermediate horizontal rails and diagonal bracing. The diagonal bracing shall run from the center of the first line post to the bottom of the terminal post.

G. Chain-Link Fabric:
   1. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released. Fasten to terminal posts and gate posts with tension bars threaded through mesh and secured with tension bands at maximum intervals of 14-inches.
   2. Tie to line posts, gate frames and top and bottom rails with tie wires spaced at maximum 12-inches on posts and 24-inches on rails.
   3. Connect tension bars to posts and frames by means of adjustable bolts and bands spaced not more than 14-inches apart.
   4. Leave approximately 2-inches between finish grade and bottom selvage, except where bottom of fabric extends into concrete.
   5. Join roll of chain-link fabric by weaving a single picket into the ends of the roll to form a continuous mesh.

H. Tension Wire:
   1. Stretch tension wire taut and free of sag, from end to end of each stretch of fence and position at a height that will enable the wire to be fastened to the chain-link fabric by securing within the top 12-inches of the chain-link fabric.
   2. Fasten bottom tension wire within the bottom 6-inches of the chain-link fabric.

3. Tie tension wire to each post with not less than 6-gage galvanized wire.

I. Barbed Wire:
1. Install three parallel wires on each extension arm; on security side of fence, unless otherwise indicated
2. Pull wire taut to remove all sag and firmly install in the slots of extension arms to prevent movement or displacement.
3. Secure wire to terminal posts utilizing terminal post band arms or brace bands.
4. Extend vertical members of gates to receive the barbed wire.

J. Razor Ribbon: Install 18-inch diameter loop razor ribbon with stainless steel core around barbed wire.

K. Stretcher Bars: Thread through or clamp to fabric 4-inches on center, and secure to posts with metal bands spaced 15-inches on center.

L. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as shown on approved Shop Drawings. Adjust hardware for smooth operation and lubricate where necessary.

M. Gate Operators:
1. Mount and adjust operator on concrete pad.
2. Connect to gate and adjust for proper operation.
3. Refer to Division 26, Electrical, for electrical connections.

N. Tie Wires: Use U-shaped wires conforming to diameter of pipe. Clasp pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing.

O. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.4 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
1. Ground fencing within 100 feet of buildings, structures, walkways, and roadways at maximum intervals of 750 feet.
a. Gates and Other Fence Openings: Ground fence on each side of opening.
1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2-gage wire and bury it at least 18-inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fencing at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise shown on the Drawings.

D. Grounding Method: At each grounding location, drive a ground rod vertically until the top is 6-inches below finished grade. Connect rod to fence with No. 6-gage conductor. Connect conductor to each fence component at the grounding location, including the following:
   1. Each Barbed Wire Strand: Make grounding connections to barbed wire with wire-to-wire connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor.

3.5 SITE QUALITY CONTROL

A. Acceptance Testing:
   1. Ground-Resistance Testing Agency: Engage a qualified independent testing agency to perform site quality-control testing.
   2. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by two-point method according to IEEE 81.
   3. Desired Maximum Grounding Resistance Value: 25 ohms.
   4. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify ENGINEER promptly. Include recommendations to reduce ground resistance and proposal to accomplish the recommendations.
   5. Report: Prepare test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

6. Test and adjust automatic gate operators, controls, alarms, safety devices, hardware, limit switches and other operable components. Replace damaged or malfunctioning operable components.
   a. Energize circuits to electrical equipment and devices.
   b. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test controls, alarms, and safeties.
7. Remove damaged and malfunctioning units, replace with new units, and retest.

B. Manufacturer's Services:
1. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 1 visit, minimum 8 hours on-site, to the site. The first visit shall be for assistance in the installation of equipment. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
2. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

3.6 ADJUSTMENT AND CLEANING

A. Repair coatings damaged in the shop or during erection on-site by recoating with manufacturer's recommended repair compound, applied in accordance with manufacturer's directions.

B. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

C. Lubricate operating equipment and clean exposed surfaces.

D. Repair and replace all broken or bent components.

+ + END OF SECTION + +

SECTION 32 31 11

SECURITY GATE OPERATOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment and incidentals as required to install new gate operators and battery backup system as shown on the Drawings and as specified.
   3. Types of products required include the following:
      a. Gate operators and control systems.
      b. Auxiliary system components, accessories, fasteners and fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. UL 325, Door, Drapery, Gate, Louver, and Window Operators and System.

B. The gate operator shall be installed according to manufacturers' recommendations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical product information, specifications and installation instructions for all system components such as gate operators and motors, security, loop detectors, and communications.
   2. Furnish gate operating instructions and motor nameplate data, ratings, and other characteristics.
   3. All structural calculations verifying that all system components comply with the requirements of the Specifications.
   4. Large scale details drawn at a scale of 3-inches equals one foot for all connections and gate details, including motor mounting arrangements.
   5. Drawings at a scale of 1/4-inch equals one foot of typical fence assembly, identifying all gate swing, slide, or other operation, hardware, and accessories. Include plans, elevations, sections, with required installation and operating clearances, and details of post anchorage, attachments and bracing.
   6. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   7. Wiring Diagrams: Power and control wiring, communication and access control features. Differentiate between manufacturer-installed and

site-installed wiring and between components provided by gate operator manufacturer and those provided by others.

8. Qualifications Data: Submit qualifications data for the following:
   a. Erector.
   b. Test agency.
9. A list of all hardware, fasteners and accessories.
10. Maintenance Manual for Motorized Gate Operators: Provide five copies of manufacturer's written instructions for recommended maintenance practices. Include the following information:
    a. Product name and number.
    b. Name, address and telephone number of manufacturer and local distributor.
    c. Detailed procedures for routine maintenance and cleaning.
    d. Detailed procedures for repairs.

B. Test Reports: Submit the following:
   1. Factory test results indicating the operator's operation sequencing and electrical integrity.

C. Certificates: Submit the following:
   1. Verification that gate operators comply with the OWNER'S requirements for safety and emergency access.
   2. Verification that electrical components, devices, and accessories are listed and labeled by a testing agency acceptable to the OWNER and are marked for intended use.

D. Warranty: Submit the following:
   1. Warranty for gate operators.

1.4 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Packaging and marking shall comply with CLF 2445.
   2. Deliver materials in manufacturer’s original, unopened packaging with all factory-applied tags, labels and other identifying information intact, legible and accurately representing material approved on Shop Drawings by ENGINEER.
   3. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. CONTRACTOR shall notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.
   4. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Storage of Materials:
   1. Store all materials under weatherproof cover, off the ground and away from other construction activities.
   2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components.

C. Handling of Materials:
   1. Handle material in a manner that is in compliance with product institute standards and that will prevent damaging coatings.

1.5 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Special Warranties:
   1. Furnish manufacturer's written five-year warranty for gate operators.

PART 2 - PRODUCTS

2.1 GATE OPERATORS

A. Product and Manufacturer: Provide the following:
   1. HySecurity SlideDriver 50VF2/3 Model 222 X3 ST

B. General: Provide factory-assembled automatic gate operation system designed for gate size, type, weight, construction, use, traffic-flow patterns, and operation frequency. Provide operation system for gate specified and shown on the Drawings, of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended and provided by gate manufacturer complete with electric motor and factory pre-wired motor controls, remote-control stations, control devices, power disconnect switch, obstruction detection device, lockable weatherproof enclosures protecting controls and all operating parts, and accessories required for proper operation. Provide enclosures with corrosion--resistant-protective and decorative finish and two keys for each lock. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with Project electrical system.
   1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
   2. Provide operator in compliance with the OWNER'S requirements.
   3. Provide electronic components with built-in troubleshooting diagnostic feature.
   4. Provide units designed and wired for both right-hand/left-hand opening, permitting universal installation.

C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

D. HySecurity gate operator model SlideDriver 50VF2/3 (222 X3 ST) with Smart Touch Controller, or other comparable operator, as approved by the architect or specifier. Substitute operators that are approved will be published in an addendum, not less than ten days prior to bid opening. Requests for substitution will include the amount of savings to be passed on to the owner.

E. Operation Cycle Requirements: Provide gate operator designed to operate for not less than the following duty and cycles per hour.
   1. Medium-Duty: Ten cycles per hour.

F. Gate Operation Speed:
   1. 2 feet per second, minimum.

G. Electric Motors: High-starting torque, reversible, continuous-duty, insulated electric motors, complying with NEMA MG 1, sized to start and operate size and weight of gate considering Project's service conditions, without exceeding nameplate ratings or considering service factor.
   1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   2. Enclosure: Totally enclosed, nonventilated or fan-cooled motors, fitted with plugged drain.
   3. Thermal Protection: Internal manual reset.
   4. Motors 2 hp and Larger: 208/230 VAC single phase

H. Remote Controls: Provide electric controls separated from gate and motor and drive mechanism as indicated on the DRAWINGS and as specified below.
   1. Card Reader: As indicated on the DRAWINGS.
   2. Vehicle Loop Detector System: Provide a complete system including automatic closing timer with adjustable time delay before closing and loop detector designed to open and close gate and hold gate open until traffic clears. Provide electronic detector, with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on the Drawings, as recommended, in writing, by detection system manufacturer for function indicated.
      a. Loop: Wire, in size indicated for on-site assembly, and sealant; style for pave-over installation.

I. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor causes operator to immediately function as follows:
   1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
   2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
   3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, located on gate as follows. Connect to control circuit using gate edge transmitter and operator receiver system.
      a. Along entire gate leaf leading edge.
      b. Along entire gate leaf trailing edge.
      c. Along entire length of gate posts.
      d. Along entire length of gate guide posts.

4. Photoelectric/Infrared Sensor System: Provide a complete system designed to detect an obstruction in gate leaf path by interruption of an infrared beam in the zone pattern without permitting obstruction to contact gate.

J. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

K. Emergency Release Mechanism: Quick disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Provide system configured such that control circuit power is disconnected during manual operation.
   1. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.

L. Operating Features: Include the following:
   1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability of monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
   2. Fully Systems Compatible: With controlling circuit board capable of accepting any type of input from external devices.
   3. Master/Slave Capability: Control stations configured and wired for gate pair operation.
   4. Automatic Closing Timer: Provide circuitry with adjustable time delay before closing and with timer cut-off switch.
   5. Open Override Circuit: Provide circuitry configured to override closing commands.
   6. Reversal Time Delay: Provide time delay circuitry to protect gate system from shock load on reversal in both directions.
   7. Maximum Run Timer: Configure circuitry to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
   8. Clock Timer: Seven-day programmable for regular events.

M. Operation pre-emption by City of Phoenix Fire Department:
   1. The City of Phoenix approved Knox key switch shall be used for 24 hour Fire Department access. The emergency key switch, when activated, shall by-pass any occupant control and loop systems. When activated, the security gate will remain in the open position until deactivated by the Fire Department. Only when deactivated will the gate resume normal operation.
   2. Pre-emption device shall be installed per City of Phoenix Fire Department installation requirements.

N. Accessories: Include the following:
   1. Mounting kit including pedestal.
   2. Audio Warning Module: Provide ADA-compliant audible alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
   3. Visual Warning Module: Provide ADA-compliant visible light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.

4. UPS AC battery backup for systems up to 1 hp or VFD equipped. 208/230 VAC single phase only. 115 VAC single phase not available.
   External electric-powered lock with delay timer allowing time for lock to release before gate operates.
5. Fire box.
6. Instructional, Safety, and Warning labels and Signs: Manufacturer's standard for components and features specified in section 10 14 00 – Identification Signs.
7. SRP “Lock Box”. Coordinate with Charles Thomas of the City of Phoenix. City of Phoenix to provide lock boxes for this project.
8. Fire: “Knox Key Switch”. Key Switch shall be provided for fire department use only. Contractor to provide switches for this project.

PART 3 - EXECUTION

3.1 INSTALLATION AND ERECTION

A. Concrete: Provide concrete consisting of Portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength 2500 pounds per square inch, using at least four sacks of cement per cubic yard, 1-inch maximum size aggregate, maximum 3-inch slump, and 2-percent to 4-percent entrained air.

B. Concrete Strength: Allow concrete to attain at least 75 percent of its minimum 28-day compressive strength.

C. Gate Operators:
   1. Mount and adjust operator and UPS DC Power System on concrete pad.
   2. Connect to gate and adjust for proper operation.
   3. Install ENGINEER approved shade structure for UPS system.
   4. Refer to Division 26, Electrical, for electrical connections.
   5. Refer to Division 28, Electronic Safety and Security, for access control connections.

3.2 SITE QUALITY CONTROL

A. Acceptance Testing:
   1. Test and adjust automatic gate operators, controls, alarms, safety devices, hardware, limit switches and other operable components. Replace damaged or malfunctioning operable components.
      a. Energize circuits to electrical equipment and devices.
      b. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test controls, alarms, and safeties.
   2. Remove damaged and malfunctioning units, replace with new units, and retest.

B. Manufacturer’s Services:
   1. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training

services. The representative shall make a minimum of 2 visits, minimum 6 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. Manufacturer's representative shall test the system in the presence of the ENGINEER and verify that the operator conforms to all requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

2. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 32 31 59

VEHICLE BARRIERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install guard rails.
   2. Guard rails shall be of the galvanized, corrugated sheet steel beam type with galvanized steel posts supporting the rails.
   3. The extent of the guard rails shall be as shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details: Conform to all applicable requirements of Part 415 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is a conflict between the MAG Specification as supplemented by the City of Phoenix and these Specifications, provisions of these Specifications shall apply.

B. Provide guard rails as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 36, Specification for Structural Steel.
   2. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. AASHTO M 180, Corrugated Sheet Steel Beams for Highway Guard Rail.
   4. Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical data and installation instructions.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect the guard rails from abuse so as to prevent nicks, gouges and dents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide galvanized steel posts of size and shape as recommended by the manufacturer. Steel shall comply with ASTM A 36 and galvanized in accordance with ASTM A 123.

B. Provide guard rail complying with AASHTO M 180, Class A (12 gage), Type 2.

C. Product and Manufacturer: Provide one of the following:
   1. Deep Beam guard rail, as manufactured by Syro Steel Company.
   2. Flex Beam guard rail, as manufactured by Armco Steel Corporation.
   3. Anchor guard rail, as manufactured by Anchor Post Products, Incorporated.
   4. Or equal.

2.2 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Terminal Sections and Ends: Provide terminal sections and ends as shown on the Drawings. Where not shown on the Drawings, provide in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not begin guard rail installation and erection until paving or final grading is completed, unless otherwise acceptable to ENGINEER.

B. Drive posts, unless otherwise shown on the Drawings or directed by ENGINEER. Accomplish driving with approved equipment and methods that will leave the posts in their final position, free of distortion, burring, or other damage. When posts are driven through bituminous concrete, take care to prevent damage to the paved areas. Fill, compact and seal depressions and holes, caused by driving the posts, with bituminous concrete similar to that damaged. Posts shall be aligned to a tolerance of 1/4-inch for plumb and grade.

C. Excavation: As an alternate to driving posts on unpaved areas or where driving is not possible, excavate holes of widths and spacings shown on the Drawings, for post footings in firm, undisturbed or compacted soil.
   1. If not shown on the Drawings, excavate holes to widths as recommended by guard rail manufacturer.
   2. Spread soil from excavations uniformly adjacent to guard rail line, or on adjacent areas of the site, as directed by ENGINEER.
   3. When rock is encountered, excavate into rock to widths as recommended by the manufacturer.
   4. Setting Posts: Remove loose and foreign materials from sides and bottom of holes, and moisten soil prior to placing concrete. Place, trowel, cure and test concrete in accordance with Section 03 30 00, Cast-In-Place Concrete.

D. Where posts cannot be driven or anchored in concrete, use base plates as shown on the Drawings or as directed by ENGINEER.

E. When setting posts, align them to a tolerance of 1/4-inch for plumb and grade.

F. Rails: Connect rails to posts in accordance with manufacturer's instructions. Install terminal sections or ends.

3.2 REPAIR

A. Repair galvanized coating, damaged in the shop or during field erection, by recoating with manufacturer's recommended repair compound and applying compound in accordance with manufacturer's instructions.

+ + END OF SECTION + +

SECTION 32 80 00

IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install an underground irrigation system. It shall include irrigation connections, excavations and backfill, furnishing and installing all plastic, polyethylene and galvanized steel pipe and fittings, automatic control valves, valve access boxes, pipe sleeves, electric controller, metal controller cabinet, as required for a complete system, as shown on the Drawings or specified, and other Work as required to provide for proper operation of the system.
   2. It is intended that the system shall be a complete automatic operative system providing 100 percent coverage to all plant material, the optimum operation of which shall be guaranteed for a period of one year.

1.2 QUALITY ASSURANCE

A. Installer's Qualifications:
   1. Engage a single installer skilled, trained and with successful and documented experience for a minimum of three years in the installation of irrigation systems and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to the ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owners, architects or engineers responsible for projects.
      b. Approximate Contract Cost of the irrigation system.

B. Standard Specifications and Details:
   1. Conform to all applicable requirements of Section 440 of the Uniform Standard Specifications to Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. If there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and these Specifications, the Provisions of these Specifications shall govern.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. National Fire Protection Association (NFPA).
   2. National Electrical Code (NEC) current adoption
   3. City of Phoenix – Amendments to the National Electrical Code.
   4. American Society of Testing and Materials (ASTM).
   5. National Sanitation Foundation (NSF).
   6. The Irrigation Association (IA).

7. Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction (MAG).

D. Obtain ENGINEER'S acceptance of installed and tested irrigation system prior to installing backfill materials.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's data sheets on all irrigation system components to show compliance with the requirements specified within this Section and shown on the Drawings.

B. Record Drawings: Maintain an accurate set of drawings on site. At the end of each day's Work accomplished shall be updated on the Record Drawings. Dimension from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following:
   1. Connection to existing water lines.
   2. Connection to existing electrical power.
   3. Gate valves.
   4. Routing of Sprinkler pressure lines (dimension at a minimum of 100 feet along routing).
   5. Emitter control valves.
   6. Routing of control wiring.
   7. Quick-coupling valves.
   8. Other related equipment as directed by the ENGINEER.
   9. Indicate any non-pressure pipe routing changes on the Record Drawings.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible.

B. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded or plain.

C. Store and handle materials to prevent damage and deterioration off the ground and under cover.

D. Provide secure, locked storage for valves, sprinkler heads, and all irrigation components.

E. Comply with Section 01 65 00, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 POLYETHYLENE PIPE

A. Flexible polyethylene pipe shall conform to ASTM D 2239.

2.2 PVC PIPE AND FITTINGS

A. Schedule 40 PVC shall conform to ASTM D 2241.

B. Schedule 80 PVC pipe and molded fittings suitable for solvent weld, slip joint ring tight seal, or screwed connections. Fittings made of other material are not permitted.

C. Use male adapters for plastic to metal connections. Hand tighten male adapters, plus one turn with a strap wrench.

D. Use purple colored PVC pipe and fittings conforming to AWWA guidelines for the distribution of non-potable water. Pipe shall be identified as reclaimed water pipe by continuous markings which shall include the following as a minimum: “CAUTION: RECLAIMED WATER--DO NOT DRINK”.

2.3 INSERT FITTINGS

A. Insert type fittings, conforming to ASTM D 2466.

B. Saddle and cross fittings not permitted.

2.4 COMPONENTS

A. Refer to Irrigation Components Schedule as shown on the Drawings.

B. Automatic remote control valves shall be tagged with a purple, weatherproof tag measuring not less than 3-inch by 4-inch with the words: "WARNING-RECLAIMED WATER-DO NOT DRINK" imprinted on one side and "AVISA-AGUA IMPURA-NO TOMAR" imprinted on the other side.

C. Quick coupling valves shall be brass with a purple rubber or vinyl cover permanently imprinted with the following information:
   1. "NON-POTABLE WATER" or "RECLAIMED WATER".
   2. "DO NOT DRINK" in English and Spanish.
   3. The International "DO NOT DRINK" symbol such as an encircled glass of water with a diagonal slash through it.

D. Emitters shall be colored purple through the use of either:
   1. Dyed plastic or rubber.
   2. Weatherproof paint.

2.5 ACCESSORIES

A. Drainage fill: 1/2-inch to 3/4-inch washed pea gravel.

B. Fill: Clean soil free of stones larger than 2-inch diameter foreign matter, organic material, and debris.
   1. Provide imported fill material, as required to complete the Work. Obtain rights and pay all costs for imported materials.

2. Suitable excavated materials removed to accommodate the irrigation system Work may be used as fill materials, subject to the ENGINEER'S review and acceptance.

C. Clamps: Stainless steel, worm gear hose clamps with stainless steel screws or ear type clamps.

D. Low voltage wire connectors: Socket seal type wire connectors and waterproof sealer.

E. Valve Access boxes: Tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture corrosion and temperature changes. Provide locking lid of same material, painted purple in color, with the following permanently molded or stamped information:
1. "NON-POTABLE WATER" or "RECLAIMED WATER".
2. "DO NOT DRINK" in English and Spanish.
3. The International "DO NOT DRINK" symbol such as an encircled glass of water with a diagonal slash through it.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Examine final grades and installation conditions. Do not start irrigation system Work until unsatisfactory conditions are corrected.

B. Locate all underground and surface utility lines.

C. Layout and stake the location of each sprinkler valve, pipe run, and emitters. Obtain acceptance of layout from ENGINEER prior to excavating.

D. Promptly repair damage to adjacent facilities caused by irrigation system Work operations. Cost of repairs at CONTRACTOR'S expense.

E. Promptly notify the ENGINEER of unexpected sub-surface conditions.

F. Irrigation system layout is diagrammatic. Exact locations of piping, sprinkler heads, valves, and other components shall be established by CONTRACTOR in the field at the time of installation, with approval of ENGINEER.

G. Space irrigation components as shown on the Drawings.

H. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be approved by the ENGINEER.

I. Place sleeves as shown on the Drawings for installation of piping and control wire.

3.2 EXCAVATING AND BACKFILLING

A. All excavation shall be considered unclassified excavation and include all materials encountered, except materials that cannot be excavated by normal mechanical means. Comply with requirements of Section 31 23 00 Structural Excavation and Backfill.

B. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings.

C. Excavate to depths required to provide 2-inch depth of earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.

D. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 8-inches depth.
   1. Provide approved earth fill or sand to a point 4-inches above the top of pipe.
   2. Fill to within 6-inches of final grade with approved excavated or borrow fill materials free of lumps or rocks larger than 3-inches in any dimension.
   3. Provide clean topsoil fill free of rocks and debris for top 6-inches of fill.

E. Replace paving of same materials, using joints and patterns to match existing adjoining paving surfaces. Refer to paragraph 3.6.C in this Section.

3.3 PLASTIC PIPE

A. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction. Refer to Section 33 05 05, Buried Piping Installation.

B. Saw cut plastic pipe. Use a square-in-sawing vice, to ensure a square cut. Remove burrs and shavings at cut ends prior to installation.

C. Make plastic to plastic joints with solvent weld joints or slip seal joints. Use only solvent recommended by the pipe manufacturer. Make arrangements with pipe manufacturer for all necessary field assistance.

D. Make plastic to metal joints with plastic male adapters. Joints compound shall be Permatex Type III.

E. Make solvent weld joints in accordance with manufacturer's recommendations and instructions.

F. Allow joints to set at least 24 hours before pressure is applied to the system.

G. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods when pipe installation is not in progress.

3.4 COMPONENTS

A. Install fittings, valves, emitters, risers, and accessories in accordance with manufacturer's instructions, except as otherwise indicated.
   1. Use flex-risers in planting fingers and islands in parking areas and adjacent to sidewalks.

B. Install controllers as shown on the Drawings and as specified.

C. Install in-ground control valves in a valve access box as shown on the Drawings and as specified.

D. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box.

E. Seal threaded connections of control valves with teflon tape or approved plastic joint type compound.

F. Install drip emitters and distribution tubing where shown on the Drawings. Provide all adapters, plugs, and fittings required.

G. Install drip emitters uphill of all plants on slopes.

3.5 CONTROL WIRING

A. Electrical Requirements for Automatic Controllers - 120 volts: To be complete, in every respect, in accordance with codes, ready for use and in accordance with manufacturer's requirements. Provide separate power shut-off switch, at panel for each controller. All wiring in galvanized rigid steel conduit and fittings from source provided under Division 26, Electrical.

B. No running threads accepted, use nipples. Conduit system shall be 600 volt insulation, Phoenix Electrical Code annealed copper wire and shall be minimum AWG No. 12 TW or RW. Protect each controller by a code approved ground connection. Supply shall be 120 volts, 60 cycle, single phase, two amps. Use only stainless steel fasteners in securing controllers in position.

C. Electrical Requirements for Automatic Controllers 24 volts: To remote control valves shall be UF type, UL approved, AWG No. 14 solid strand copper wire with minimum 4/64-inch PVC coating, 600 volt, 75°C. "Common" wire to be white coated.

D. Wire Connectors for Direct Burial Conductors 24 volts: 600 volt, 60 degrees centigrade, AWG-UF type, waterproof, epoxy or PVC compound filled containers.

E. Di-Electric Isolation: Provide between all connections joining ferrous and non-ferrous metals, or existing ferrous metals and ferrous metals. Submit for approval type intended for use.

F. Install electric control cable in the piping trenches wherever possible. Place wire in trench adjacent to pipe. Install wire with slack to allow for thermal expansion and contraction. Expansion joints in wire may be provided at 200-foot intervals by making five or six turns of the wire around a piece of 1/2-inch pipe, instead of slack. Where necessary to run wire in a separate trench, provide a minimum cover of 12-inches.

G. Provide sufficient slack at site connections at remote control valves in control boxes, and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.

H. Connect each remote control valve to one station of a controller, except as otherwise indicated.

I. Connect remote control valves to a common ground wire system independent of all other controllers.

J. Make wire connections to remote control electric valves and splices of wire in the field using wire connectors and sealing cement, in accordance with manufacturer's recommendations.

K. Provide tight joints to prevent leak build-up on the joint.

3.6 SLEEVES

A. Install schedule 40 PVC sleeves, including one spare sleeve, prior to paving installation.

B. Provide 24-inch cover for sleeves under pavement. Sleeves shall be Schedule 40.

C. Remove and replace existing concrete and asphalt surfaces where cutting is required. Comply with requirements of Section 32 12 00, Bituminous Paving. Obtain OWNER'S permission before cutting existing concrete and asphalt surfaces. Where piping is shown on the Drawings under paved areas which are adjacent to landscape areas, install the piping in the landscape areas. Replacement paving shall match existing.

3.7 FLUSHING, TESTING, AND ADJUSTMENT

A. After irrigation piping and risers are installed and before emitter heads are installed, open control valves and flush out the system with full head of water.

B. Perform system testing in conformance with MAG Section 440.7, upon completion of each section. Make necessary repairs and retest sections, as required.

C. Adjust all electric remote control valve pressure regulators and flow control stems for system balance and optimum performance.

D. Test and demonstrate the controller by operating appropriate day, hour, and station selection features, as required, to automatically start and shut down irrigation cycles to accommodate plant requirements and weather conditions.

3.8 DISPOSAL OF WASTE MATERIAL

A. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.

B. Maintain disposal route clear, clean, and free of debris.

3.9 ACCEPTANCE

A. Test and demonstrate to the ENGINEER and OWNER the satisfactory operation of the system free of leaks.
B. Instruct the OWNER'S designated personnel in the operation of the system, including adjustment of sprinklers, controllers and valves. Comply with requirements of Section 01 79 00, Instruction of Operations and Maintenance Personnel.

+ + END OF SECTION + +

SECTION 33 05 05

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform all excavating, backfilling, filling, grading and disposing of earth materials and to furnish, install and test all buried piping, fittings, and specials. The Work includes, but is not limited to, the following:
      a. Excavation and backfill.
      b. All temporary means required to prevent discharge of sediment to water courses from dewatering systems or erosion.
      c. All types and sizes of buried piping, except those specified under other Sections.
      d. Piping beneath structures.
      e. Restraints and thrust blocks.
      f. Pipe encasements.
      g. Work on or affecting existing piping.
      h. Testing.
      i. Cleaning and disinfecting.
      j. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the buried piping installation.
      k. Incorporation of valves, meters and special items shown on the Drawings or specified into the piping systems as required and as specified in the appropriate Mechanical Sections.
      l. Unless otherwise specifically shown on the Drawings, specified, or included under other Sections, all buried piping Work required, beginning at the outside face of structures or structure foundations and extending away from structure.
   2. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.
   2. Section 33 05 05, Buried Piping Installation, specifies the installation of all buried piping materials. Coordinate with all applicable Sections.

1.2 QUALITY ASSURANCE

A. Conform to all requirements of Section 601 of the Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG),

as supplemented by the City of Phoenix. If there is a conflict between MAG Standard Specifications and these Specifications, the Provisions of these Specifications shall govern.

B. Testing Services:
   1. General: Testing of materials, testing for moisture content during placement and compaction of fill materials, and of compaction requirements for compliance with technical requirements of the Specifications shall be performed by a testing laboratory as designated in Section 01 45 29.15, Testing Laboratory Services Furnished by OWNER, and Section 01 45 29.20, Testing Laboratory Services Furnished by CONTRACTOR.
   2. OWNER'S Testing Agency Scope:
      a. Test CONTRACTOR'S proposed materials in the laboratory and/or field for compliance with the Specifications.
      b. Perform field moisture content and density tests to assure that the specified compaction of backfill materials has been obtained.
      c. Report all test results to the ENGINEER and CONTRACTOR.
   3. Authority and Duties of OWNER'S Testing Agency: Technicians representing the testing laboratory shall inspect the materials in the field and perform tests and shall report their findings to the ENGINEER and CONTRACTOR. When the materials furnished or Work performed fails to fulfill Specification requirements, the technician will direct the attention of the ENGINEER and CONTRACTOR to such failure.
      a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is not discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Contract Documents, nor to approve or accept any portion of the Work.
   4. Responsibilities and Duties of CONTRACTOR:
      a. The use of testing services shall in no way relieve CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
      b. To facilitate testing services:
         1) Secure and deliver to the ENGINEER or to the testing agency, without cost, preliminary representative samples of the materials he proposes to use and which are required to be tested.
         2) Furnish such casual labor as is necessary to obtain and handle samples at the Work site or at other sources of material.
         3) Advise the OWNER'S testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.
      c. CONTRACTOR'S Testing Service shall inspect and approve subgrades and fill layers before further construction Work is performed thereon.
      d. Responsibility belongs to CONTRACTOR to accomplish the specified compaction for backfill and to control the operations by confirmation tests to verify and confirm compliance, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

e. The frequency of CONTRACTOR'S confirmation tests shall be not less than as follows; each test location for trenches shall include tests for each layer, type, or class of backfill from bedding to finish grade.
   1) Trenches for buried pipe:
      a) In open fields: locations every 1,000 linear feet.
      b) Along dirt or gravel roads or off traveled right-of-way: locations every 500 linear feet.
      c) Crossing paved roads: locations along each crossing.
      d) Under pavement cuts or within two feet of pavement edges: location every 400 linear feet.

f. Copies of the test reports shall be submitted promptly to the ENGINEER. CONTRACTOR'S tests shall be performed by a soils testing laboratory acceptable to the ENGINEER.

g. Demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
   1) 200 linear feet of trench backfill.

h. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.

i. Periodic compliance tests will be made by the ENGINEER to verify that compaction is conforming to the requirements previously specified, at no cost to CONTRACTOR. Remove the overburden above the level at which the ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete.

j. If compaction fails to conform to the specified requirements, remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR'S confirmation tests shall be performed in a manner acceptable to the ENGINEER. Frequency of confirmation tests for remedial Work shall be double that amount specified for initial confirmation tests.

C. Requirements of Regulatory Agencies:
   1. Comply with requirements of NFPA Standard No. 24 for “Outside Protection” where applicable to water pipe systems used for fire protection.
   2. Comply with requirements of UL, FM and other jurisdictional authorities, where applicable.
   3. Refer to the General and Supplementary Conditions regarding permit requirements for this Project.
   4. Comply with requirements of Phoenix Building Code.
   5. Obtain all necessary permits for Work in roads, rights-of-way, railroads, etc. Also, obtain permits as required by local, state and federal agencies for discharging water from excavations.
   6. Perform excavation Work in compliance with applicable requirements of governing authorities having jurisdiction.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Excavation and Backfill:

a. ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils.
b. ASTM D 427, Test Method for Shrinkage Factors of Soils by the Mercury Method.
c. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil.
d. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
e. ASTM D 2166, Standard Test Method for Unconfined Compression Strength of Cohesive Soil.
f. ASTM D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
g. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
h. ASTM D 4318, Method of Test for Liquid Limit of Soils.
i. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
j. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section 650 (Subpart P - Excavations).
k. AASHTO T-99, The Moisture-Density Relations of Soils Using a (2.5 kg) 5.5 lb Rammer and a (305 mm) 12 in. Drop Proctor
l. ASSHTO-T-191, Density of Soil in Place by the Sand Cone Method.
m. Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG), as supplemented by the City of Phoenix, Section 601.

2. Piping Materials and Installation:
   a. ASTM D 2321, Practice for Underground Installation of Flexible Thermoplastic Pipe.
   b. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
   c. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
   d. AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. AWWA C206, Field Welding of Steel Water Pipe.
   f. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
   g. AWWA C606, Grooved and Shouldered Joints.
   h. AWWA C651, Disinfecting Water Mains.
   i. AWWA M9, Concrete Pressure Pipe.
   j. AWWA M11, Steel Pipe - A Guide for Design and Installation.
   k. AWWA M23, PVC - Design and Installation.
   l. ASCE MOP No. 37, Design and Construction of Sanitary and Storm Sewers.
   m. Concrete Pipe Handbook, American Concrete Pipe Association.
   n. NFPA 24, Private Fire Service Mains and Their Appurtenances.
   o. NFPA 54, National Fuel Gas Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Excavation and Backfill Submittals:

a. Excavation Plan: Prior to start of excavation operations, a written plan shall be submitted to demonstrate compliance with OSHA Standard 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
   1) Name of competent person.
   2) Excavation method(s) or protective system(s) to be used.
   3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
b. Excavation and backfill requirements detailing sheeting and bracing, or other protective system(s), dewatering systems, cofferdams, and under-pinning.
c. Shop Drawings shall be prepared by a Registered Professional Engineer, licensed in the State of Arizona, recognized as an expert in the specialty involved. Drawings shall be submitted to ENGINEER for record purposes only. Calculations shall not be submitted. Drawing submittals will not be checked and will not imply approval by ENGINEER of the Work involved. Responsibility belongs to CONTRACTOR for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering.
d. Samples of all materials, including select backfill, general backfill, granular embedment, crushed stone and sand shall be submitted to the ENGINEER and the testing service. Samples of the proposed material shall be submitted at least 14 days in advance of its anticipated use.

2. Piping Materials and Installation Submittals:
   a. Laying schedules for all piping
   b. Full details of piping, specials, manholes, joints, harnessing and thrust blocks, and connections to existing piping, structures, equipment and appurtenances.
   c. Certificates of compliance with referenced Standards for proposed pipe material.
   d. Descriptions of proposed pipe testing methods, procedures and apparatus. Prepare and submit a report for each test conducted.
3. Field Test Reports:
   a. Testing laboratory shall submit copies of test reports for Field Density of Backfill directly to ENGINEER, with copy to CONTRACTOR
4. Record Drawings:
   a. During progress of the Work, keep an up-to-date set of Record Drawings showing field and Shop Drawing modifications.
   b. Submit Record Drawings prior to the time of Substantial Completion.

1.4 JOB CONDITIONS

A. Subsurface Information: Refer to Section 00 70 00, General Conditions, and Section 00 80 00, Supplementary Conditions, for available data on subsurface conditions. The data is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. OWNER will not be responsible for interpretations or conclusions drawn there from by CONTRACTOR. Data is solely made available for the convenience of CONTRACTOR.
   1. Additional test borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER.

B. Existing Structures: The Drawings show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown on the Drawings for the convenience of CONTRACTOR. Explore ahead of the required excavation to determine the exact location of all existing structures. Structures shall be supported and protected from damage by CONTRACTOR. If they are broken or damaged, restore them immediately at no additional cost to the OWNER.

C. Existing Utilities: Locate existing underground utilities in the areas of the Work. If utilities are to remain in place, provide adequate means of protection during all operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult piping or utility owner and ENGINEER immediately for directions as to procedure. Cooperate with OWNER and utility owner in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner. Comply with requirements of Section 01 14 16, Coordination With OWNER'S Operations.
   2. In general, service lines to individual houses and businesses are not shown on the Drawings, however, assume that a service exists for each utility to each house or business.
   3. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.
   4. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. Use of Explosives:
   1. The use of explosives will not be permitted. Comply with requirements of Section 02 41 00, Demolitions.
   2. Do not bring explosives onto site or use in the Work without prior written permission from authorities having jurisdiction. Provide copy of authorization to ENGINEER. Sole responsibility for handling, storage and use of explosive materials, when their use is permitted, belongs to CONTRACTOR.

E. Protection of Persons and Property: Barricade open excavations occurring as part of the Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

F. Dust Control: Conduct all operations meeting the requirements specified in Section 01 41 27, Earthmoving and Dust Control.

G. Roadways and Walks: Unless otherwise approved by ENGINEER, excavated material and materials of construction shall be so deposited, and the Work shall be so conducted, as to leave open and free for pedestrian traffic all crosswalks, and for vehicular traffic a roadway not less than ten feet in width. All hydrants, valves, fire alarm boxes, letter boxes, and other facilities which may require access during

construction shall be kept accessible for use. During the progress of the Work, maintain such crosswalks, sidewalks, and roadways in satisfactory condition and the Work shall at all times be so conducted as to cause a minimum of inconvenience to public travel, and to permit safe and convenient access to private and public property along the line of the Work.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or otherwise damaged material and immediately remove from site.

PART 2 - PRODUCTS

2.1 EMBEDMENT AND BACKFILL MATERIALS

A. Pipe Bedding/Granular Embedment:
   1. Bedding is the material placed in the area from the bottom of the trench to one foot above the top of the pipe. Pipe bedding shall be Select Material Type B or Aggregate Base Course having the following gradation. Open graded rock will not be used without the written approval of the ENGINEER.

Sieve Sizes (Square Opening)	Percentage by Weight Passing Sieve	
	Select Material Type B	Aggregate Base Course
1-1/2-inch	100	
1-1/4-inch	100	100
No. 4	30 – 70	38 - 65
No. 8	20 – 60	25 – 60
No. 30	10 – 40	10 – 40
No. 200	0 - 12	3 - 12

   2. Unless otherwise noted, the Plasticity Index as tested in accordance with AASHTO T-146, T-89 and T-90 shall not be more than five.

B. Sand:
   1. Sand for use as embedment material around plastic pipes (CPVC, FRP Duct, and HDPE Duct) shall consist of natural or manufactured granular material.

2. No sand will be allowed for embedment material around centrifugally cast, fiberglass reinforced polymer mortar pipe.
3. Sand material shall contain no organic material. Sand shall be nonplastic, when tested in accordance with ASTM D 698, 100 percent shall pass a 1/2-inch screen and no more than 20 percent shall pass a No. 200 screen.
4. All material for sand must be tested and approved by the ENGINEER.
5. No sand shall be placed without the approval of the ENGINEER.

C. Encasement Material:
1. Pipe encasement material shall be Type 2 Portland cement concrete as specified in Section 03 30 00, Cast-In-Place Concrete (Large Projects), unless otherwise shown on the Drawings.

D. Backfill Material:
1. Materials acceptable for use as backfill above the pipe embedment shall be:
a. Stockpiled native sandy clay or granular soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 3-inches in size, nor have greater than 40 percent passing the 200 sieve. The maximum expansion of on-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 pound per square foot (psf) surcharge pressure.
b. Materials from off-site sources shall consist of silty or clayey sand soils which are uniformly mixed, contain no organic matter and which have a Plasticity Index less than ten. The maximum particle size of imported soils shall be 3-inches or less, if required to satisfy trenching, landscaping, or other requirements. The maximum expansion of off-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
c. All materials for use as backfill material shall be tested by the laboratory and approved by the ENGINEER.
d. If on-site material is unsuitable as determined by the ENGINEER, select backfill or approved off-site fill shall be used.

2.2 PIPING MATERIALS

A. Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed in Section 33 14 10, Piping Systems. Piping materials shall conform to detailed Specifications for each type of pipe and piping appurtenances specified in the applicable Sections.

2.3 PIPING IDENTIFICATION

A. Plastic Tracer Tape and Magnetic Tracer Tape Marking shall conform to the requirements specified in Section 33 14 00, Piping Systems.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavation is to be performed. ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

B. Perform all excavation required to complete the Work as shown on the Drawings, specified and required. Excavations shall include earth, sand, clay, gravel, hardpan, boulders not requiring drilling and blasting for removal, decomposed rock, pavements, rubbish and all other materials within the excavation limits.

C. Excavations for pipelines shall be open excavations. Provide excavation protection system(s) required by ordinances, codes, law and regulations to prevent injury to workmen and to prevent damage to new and existing structures or pipelines. Unless shown on the Drawings or specified otherwise, protection system(s) shall be utilized under the following conditions.
   1. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   2. Excavations More Than Five Feet Deep: Excavations in stable rock where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded or shored and braced.
   3. Excavation protection system(s) shall be installed and maintained in accordance with drawings submitted under Article 1.3, above.

D. Where the pipeline is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of said pipeline under dry conditions. Dry conditions shall prevail until the pipelines are properly jointed, tested and backfilled. Water level shall be maintained below top of backfill at all times.

E. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade.

F. Except where otherwise noted on the Drawings, or approved, in writing, by the ENGINEER, no more than 60 feet of trench may be opened in advance of pipe laying.

G. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

   1. Locate and retain soil materials away from edge of excavations.
   2. Dispose of excess soil material and waste materials as specified hereinafter.

3. Stockpiled excavated soils for use as subsequent fill shall be classified by laboratory as on-site granular or sandy clay soils. Use and placement of fill shall be performed as specified for each class.
4. Excess soil from excavations shall be disposed of off-site. Disposal shall be in accordance with state and local regulatory requirements

H. Trench width shall be minimized to greatest extent practical but shall conform to the following:
1. Sufficient to provide room for installing, jointing and inspecting piping. Trenches for other than cast-in-place concrete pipe shall conform to the dimensions listed below, unless otherwise shown on the Drawings, and/or approved by the ENGINEER.

Size of Pipe (I.D.) (Inches)	Maximum Width at Top of Pipe Greater than O.D. of Barrel	Minimum Width at Springline Each Side of Pipe
Less than 18	16-inches	6-inches
18 to 24 inclusive	19-inches	8-inches
27 to 39 inclusive	22-inches	9-inches
42 to 60 inclusive	1/2 of Pipe O.D.	12-inches
Over 60	36-inches	12-inches

2. The width of the trench shall not be greater than the maximum indicated above, at and below the level of the top of the pipe. If the maximum width as specified above is exceeded at the top of the pipe, provide, at no additional cost to the OWNER, the necessary loading bearing capacity by means of bedding, having a higher bedding factor that that specified, higher strength pipe a concrete cradle, cap or encasement, or by other means approved in writing by the ENGINEER.
3. The width of the trench above that level may be made as wide as necessary for shoring or other wall support measures necessary for a safe and proper installation. Trench walls may be sloped in-lieu of shoring, sheeting or other wall support measures. In all cases, responsibility belongs to CONTRACTOR for all costs incurred as a result of increased trench width.
4. Enlargements at pipe joints may be made if required and approved by ENGINEER.
5. Sufficient for shoring and bracing, or shielding and dewatering.
6. Sufficient to allow thorough compaction of embedment material adjacent to bottom half of pipe.

I. Depth of trench shall be as required to install the piping at the elevations shown on the Drawings. For all pipe 12-inches or greater in diameter, excavate for and provide an initial bedding layer at least 4-inches thick or 1/2 the outside diameter of the pipe whichever is greater. If required and approved by ENGINEER, depths may be revised. Remove all loose and unsuitable material from the trench bottom.

J. Subgrades for trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Where ENGINEER considers the existing subgrades unsuitable, remove same and replace

it with granular embedment material. Subgrades which are otherwise solid, but which become soft or mucky on top due to construction operations, shall be reinforced with granular embedment material. The finished elevation of stabilized subgrades shall not be above subgrade elevations required for the piping installation as herein specified. Proof roll all subgrades prior to placing of select fill and general fill material.

K. Except at locations where excavation of rock from the bottom of the trench is required, care shall be taken not to excavate below the required depth. Unauthorized excavation below the specified grade line shall be refilled at CONTRACTOR'S expense with aggregate base material compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTO T-99 and T-191 or ASTM D-2922 and D-3017. When AASHTOT-99, Method A or B, and T-191 are used for density determination, MAG, Detail 190, will be used for rock correction.

L. Whenever rock is encountered in the trench bottom, it shall be over excavated to a minimum depth of 6-inches below the O.D. of the pipe. This over excavation shall be filled with granular embedment material and compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTOT-99 and T-191 or ASTM D-2922 and D-3017.

M. Where pipe is laid in rock excavation, crushed stone as specified in Section 31 23 23.11, Crushed Stone, Gravel and Decomposed Granite, shall be carefully placed and tamped over the rock before the pipe is laid. Depth of crushed stone shall be at least 6-inches for pipe 16-inches and smaller and 9-inches for pipe 18-inches and larger. After laying pipe, the balance of the embedment and backfill shall be placed as described herein.

3.2 EXCAVATION DRAINAGE AND DEWATERING

A. General:
   1. Prevent surface and subsurface water from flowing into excavations and from flooding adjacent areas.
   2. Remove water from excavations as fast as it collects.
   3. Maintain the ground water level at approximately three feet below the bottom of the excavation to provide a stable surface for construction operations, a stable subgrade for permanent work and to prevent damage to Work during all stages of construction.
   4. Provide and maintain pumps, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations. Adequate operational standby equipment shall be maintained on the site.
   5. Provide approved sediment traps when water is conveyed into water courses.
   6. Obtain ENGINEER'S approval before shutting down dewatering system for any reason.

B. Standby Requirements for Dewatering:
   1. Provide standby equipment to ensure continuity of dewatering operations.

C. Disposal of Water Removed by Dewatering System:

1. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
2. Dispose of water in such a manner as to cause no inconvenience to OWNER, ENGINEER or others involved in work about the site.
3. Convey water from the excavation in a closed conduit. Do not use trench excavations as temporary drainage ditches.

3.3 PIPE BEDDING/GRANULAR EMBEDMENT

A. Bedding/Granular Embedment shall be placed in the trench from the bottom of the trench to one foot above the top of the pipe.

B. Sand shall be placed as an envelope around CPVC pipes, FRP ducts and all pipe 2-inches and smaller. Place and compact minimum 6-inches of sand all around pipes, in 6-inch lifts, to level 12-inches above the top of pipe. The backfill shall be compacted to not less than 95 percent of laboratory maximum density as determined by AASHTOT-99 and T-191.

C. Carefully place and thoroughly compact all pipe bedding with hand held pneumatic compactors as construction progresses.

D. Granular embedment shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle. After each pipe has been graded, aligned, placed in final position on the bedding material and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and to maintain alignment during subsequent pipe jointing and embedment operations. Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

3.4 PIPE INSTALLATION

A. General:
   1. All bedding shall be inspected by ENGINEER prior to laying pipe. Notify ENGINEER in advance of excavating, bedding and pipe laying operations.
   2. The ENGINEER prior to installation shall inspect all piping. ENGINEER'S inspection will not relieve CONTRACTOR or manufacturer from responsibility for damaged products.
   3. All piping shall be carefully examined for cracks, damage or other defects before installation. Any piping that is defective, including but not limited to, cracked, damaged, in poor condition, or with damaged linings or improper markings shall be rejected, unless the product can be repaired in a manner acceptable to the manufacturer and ENGINEER. Any piping found to be broken or defective after it has been installed shall be removed, replaced or repaired at CONTRACTOR'S expense.
   4. Take field measurements, where required, prior to installation to ensure proper fitting of the Work. Uncover existing pipelines sufficiently in advance of the proposed Work in order that the type and location of the existing pipes and

joints and other information required to fabricate the proposed piping can be determined. Responsibility to obtain whatever information is required to complete the connections of the proposed pipelines to the existing pipelines belongs to CONTRACTOR.

5. Present all conflicts between piping systems and equipment, structures or facilities to ENGINEER for determination of corrective measures before proceeding.
6. Request instructions from ENGINEER before proceeding if there is a conflict between the manufacturer's recommendations and the Contract Documents.
7. Installation of all pipe, fittings, valves, specials and appurtenances shall be subject to the review and approval of the ENGINEER.
8. Install piping as shown on the Drawings, specified and as recommended by the manufacturer and in conformance with referenced standards and approved Shop Drawings.
9. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.
10. Minimum earth cover over the piping shall be as shown on the Drawings, specified or directed by the ENGINEER.
11. Interior of all piping and mating surfaces shall be inspected and all dirt, gravel, sand, debris or other foreign material shall be completely removed from the interior and mating surfaces before installation. Measures shall be taken to maintain the interior of all piping clean until acceptance of the completed Work. Care shall be taken to prevent foreign matter from entering joint space. Bell and spigot mating surfaces shall be wiped clean immediately before piping is laid. For ductile-iron pipe, the bell and spigot mating surfaces shall be thoroughly cleaned with a wire brush.
12. Install piping accurately to line and grade shown on the Drawings, specified or directed, unless otherwise approved by the ENGINEER. Accurate means of determining and checking the alignment and grade shall be used, which shall be subject to the approval of the ENGINEER. Any modifications to the Contract Documents to suit the pipe manufacturer's standard shall be approved by the ENGINEER. Remove and relay piping that is incorrectly installed, at CONTRACTOR'S expense.
13. Do not lay piping in water, unless otherwise specified in these Specifications or approved by the ENGINEER. Ensure that the water level in the trench is at least 6-inches below the bottom of piping. Maintain a dry trench until jointing and backfilling are complete, unless otherwise specified in these Specifications or approved by the ENGINEER.
14. Where unforeseen conditions will not permit the installation of piping as shown on the Drawings or specified, no piping shall be installed without approval of the ENGINEER. Do not modify structures or facilities without approval of the ENGINEER.
15. Start laying piping at lowest point and proceed toward the higher elevations, unless otherwise approved by the ENGINEER. Slope piping uniformly between elevations shown on the Drawings or as otherwise directed by the ENGINEER.
16. Place bell and spigot piping so that the bells face the direction of laying, unless otherwise approved by the ENGINEER.
17. Piping shall be installed so that the barrel of the piping, and not the joints, receives the bearing pressure from the trench bottom or other bedding condition.

18. No piping shall be brought into position until the preceding length, valve, fitting, or special has been bedded and secured in place.
19. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, water and other foreign matter from entering the piping.
20. Field cutting of metallic piping, where required for inserting valves, fitting, specials, and closures, shall be made with a machine specially designed for cutting piping and in accordance with the manufacturer's instructions. Cuts shall be carefully done, without damage to piping, so as to leave a smooth end at right angles to the axis of the piping. Cut end shall be tapered and sharp edges filed off smooth. Flame cutting shall not be permitted. Any piping damaged by CONTRACTOR due to improper or careless methods of cutting shall be replaced or repaired at his expense.
21. Blocking under piping shall not be permitted, unless specifically approved by ENGINEER for special conditions.
22. Protective linings and coatings shall be touched up prior to installation, where required.
23. Except where bends, wyes or similar fittings are used, changes in alignment and grade of the piping shall be made by deflecting joints or with beveled pipe. Permissible joint deflection shall not exceed 75 percent of the amount allowed by the manufacturer.
24. All joints shall be made in the presence of the ENGINEER or his duly authorized representative, except as otherwise approved.
25. Special care shall be taken to ensure that each section of piping abuts against the next in such a manner that there will be not shoulder or unevenness of any kind along the piping invert.
26. Piping shall be rotated as required to place outlets in proper position.
27. Blind flanges and cleanouts shall be provided at locations shown on the Drawings, specified or required. Cleanouts on buried piping shall include all pipe, fittings and appurtenances required to bring cleanout to finished grade and terminate in a flange and blind flange or suitably capped piping as shown on the Drawings. Cleanout piping shall be same as that specified for the main run.
28. All gravity lines shall pitch uniformly at the grade shown on the Drawings or as specified or approved by the ENGINEER.
29. Short pipe stubs, maximum 4’-0” in length, shall be used at all manholes and other wall faces, except as otherwise specified.
30. Field painting shall be accomplished after joints are made.
31. All piping shall be plugged watertight with a suitable cap or plug securely fastened to the end of the piping at all contact interfaces.
32. On steep slopes, take measures acceptable to ENGINEER to prevent movement of the pipe during installation.
33. Thrust Restraint: During the installation of the pipe, thrust blocks, tied joints, or proprietary restrained joint systems shall be provided wherever required for thrust restraint. Thrust restraint shall conform to the applicable requirements of Article 3.4, below.
34. Exercise care to avoid flotation when installing pipe in cast-in-place concrete.
35. For copper tubing and thermoplastic piping, snake piping in trench to compensate for thermal expansion.

B. Manufacturer's Installation Specialist:

1. Provide the services of a competent installation specialist of the pipe manufacturer when pipe laying commences if CONTRACTOR is not experienced in laying and jointing a particular type of pipe for the following:
   a. Concrete pipe.
   b. FRP pipe.
   c. Thermoplastic pipe.
   d. Centrifugally cast, fiberglass-reinforced polymer mortar pipe.
2. Retain installation specialist at the site for a minimum of 3 days or until competency of the pipe laying crew has been satisfactorily demonstrated.

C. Separation of Sewers and Potable Water Pipe Lines:
   1. Conform to requirements of MAG Specification Section 610.5

D. Plugs:
   1. Temporarily plug installed pipe at the end of each day's Work or other interruption to the installation of any pipeline. Plugging shall prevent the entry of animals, liquids or persons into the pipe or the entrance or insertion of deleterious materials.
   2. Install standard plugs into all bells at dead ends, tees or crosses. Cap all spigot ends.
   3. Fully secure and block all plugs and caps installed for pressure testing to withstand the specified test pressure.
   4. Where plugging is required for phasing of the Work or for subsequent connection of piping, install watertight, permanent type plugs.

E. Laying Pipe:
   1. Conform to manufacturer's instructions and requirements of the standards listed below, where applicable:
      a. Ductile Iron Pipe: AWWA C600, AWWA C105.
      b. Concrete Pipe: AWWA M9, Concrete Pipe Handbook.
      c. Steel Pipe: AWWA M11, AWWA C206.
      d. Thermoplastic Pipe: ASTM D 2774.
      e. Fiberglass Reinforced Polymer Mortar Pipe: AWWA C950.
      f. ASCE Manual of Practice No. 37.

F. Polyethylene Encasement:
   1. Provide polyethylene encasement for ductile iron piping to prevent contact between the pipe and surrounding bedding material and backfill.
   2. Polyethylene may be supplied in tubes or in sheet material.
   3. Polyethylene encasement materials and installation shall be in accordance with the requirements of MAG Section 610.5.

G. Jointing Pipe:
   1. Ductile Iron Mechanical Joint Pipe:
      a. Comply with requirements of Section 33 05 19, Ductile Iron Pipe.
      b. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
      c. Lubricate the plain ends and gasket with soapy water or an approved pipe lubricant, in accordance with AWWA C111, just prior to slipping the gasket onto the plain end of the joint assembly.

d. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
e. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
f. Push gland toward socket and center it around pipe with the gland lip against the gasket.
g. Insert bolts and hand tighten nuts.
h. Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1-1/4	120 to 150

i. All bolts and nuts shall be heavily coated with two 10-mil minimum coats of coal-tar epoxy coating as manufactured by Tnemec, or equal.
j. Restrained mechanical joints shall be in accordance with Section 33 05 19, Ductile Iron Pipe.

2. Ductile Iron Push-On Joint Pipe:
   a. Comply with requirements of Section 33 05 19, Ductile Iron Pipe.
   b. Prior to assembling the joints, the last 8-inches of the exterior surface of the spigot and the interior surface of the bell shall be thoroughly cleaned with a wire brush, except where joints are lined or coated with a special protective lining or coating.
   c. Rubber gaskets shall be wiped clean and flexed until resilient. Refer to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
   d. Insert gasket into joint recess and smooth out the entire circumference of the gasket to remove bulges and to prevent interference with the proper entry of the spigot of the entering pipe.
   e. Immediately prior to joint assembly, apply a thin film of approved lubricant to the surface of the gasket which will come in contact with the entering spigot end of pipe. Option, apply a thin film of lubricant to the outside of the spigot of the entering pipe.
   f. f. For assembly, center spigot in the pipe bell and push pipe forward until it just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled all the way home, carefully check the gasket for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot end of the entering pipe past the rubber gasket until it makes contact with the base of the bell. When more than a reasonable amount of force is required to assemble the joint, the spigot end of the pipe shall be removed to verify the proper positioning of the rubber gasket. Gaskets which have been scoured or otherwise damaged shall not be used.

g. g. Maintain an adequate supply of gaskets and joint lubricant at the site at all times when pipe jointing operations are in progress.

3. Proprietary Joints:
   a. Pipe which utilizes proprietary joints such as Megalug, by EBBA Iron, Inc.; Lok-Ring, by American Cast Iron Pipe Company; restrained joints described under Article 3.4, or other such joints shall be installed in strict accordance with the manufacturer's instructions.
4. Flanged Joints:
   a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by ENGINEER. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Bolts shall be tightened in a sequence which will ensure equal distribution of bolt loads.
   c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. No washers shall be used.
   d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly.
   e. After assembly, coat all bolts and nuts with two 8-mil coats of a high-build epoxy or bituminous coating as manufactured by Tnemec, or equal.
5. Prestressed Concrete Cylinder Pipe Joints:
   a. Immediately before making the joint, completely clean the bell and spigot surfaces to be jointed.
   b. Apply a lubricant supplied by the pipe manufacturer to the sealing surfaces of the bell and spigot and the gasket. After lubrication, install the gasket in the spigot groove and ensure that the stretch in the gasket is equalized.
   c. After the pipe is lowered into place, align the spigot and bell so that the spigot will squarely enter the bell.
   d. Before the joint is fully assembled, check the position of the gasket in the bell using methods recommended by the pipe manufacturer and approved by the ENGINEER.
   e. If the gasket is found to be in the correct position around the entire circumference of the bell, remove temporary joint stoppers, if used, and shove the pipe completely home. If the gasket is not in the proper location, the joint shall be opened and reinstalled using a new gasket.
   f. Where a joint opening is required to make a grade or alignment adjustment, the joint shall be installed completely closed first, then opened as necessary on one side. Joint openings shall not be greater than 75 percent of the maximum opening recommended by the pipe manufacturer.
   g. Strap a diaper to the outside of the completed joint straddling the external joint recess. Pour a grout mix consisting of Portland cement and sand in proportions recommended by the pipe manufacturer to completely fill the external joint recess. In lieu of the joint diaper, with written approval of the pipe manufacturer, use a polyurethane foam joint protector with unhydrated Portland cement dispersed throughout the protector. The protector shall have the cross-sectional shape required for the type of joint being installed and shall be formed in a loop to fit the size of pipe on which it is to be used.

h. Point interior joint recess of all pipe 24-inches in diameter and larger with Portland cement/sand mortar mixed in proportions recommended by the pipe manufacturer. Strike off grout smooth with the interior face of the pipe. For pipes 20-inches in diameter and smaller which convey sewage or nonpotable water, the interior surfaces of the steel joint ring shall be protected by a flexible mastic joint filler applied to the bell socket just prior to joining the pipe such that the mastic squeezes out to fill the internal joint recess.
i. Coat all exterior exposed steel portions of the pipe, flanges, couplings, bolts and nuts with two 8-mil coats of high-build epoxy or bituminous coating as manufactured by Tnemec, or equal.
j. Maintain a sufficient quantity of joint lubricant, gaskets, joint diapers and joint fillers at the site of the Work at all times.
k. Do not use gaskets which have been scored or otherwise damaged.
l. Where welded joints are required to handle thrust, the steel spigot shall be cut at the trailing edge of the gasket groove to provide a surface suitable for welding in the field. All field welded joints shall be full circumferential welds designed to take the thrust at the joint location. A minimum 3/16-inch weld is required. The exposed steel surface of the pipe joints shall have a temporary protection system of a rust and corrosion inhibitor applied which need not be removed prior to welding. After welding is complete, the joint protection shall be completed with interior and exterior cement mortar grouting.

6. Steel Pipe Joints:
   a. Joints in steel pipe shall be butt welded joints, except that flexible couplings, mechanical couplings, or flanged connections shall be provided at connections to valves, meters and similar equipment.
   b. Welding shall conform to the requirements of AWWA C206. Pipe 36-inches in diameter and larger shall be welded both inside and outside of the pipe.
   c. After welding, the joint and the surrounding damaged or uncoated area shall be coated with the same material and to the same thickness as the shop applied coating.
   d. Where flanged connections or couplings are provided, the flanges, couplings, bolts and nuts shall be coated with two 8-mil coats of high-build epoxy or bituminous coating as manufactured by Tnemec, or equal.
7. Thermoplastic Pipe Joints:
   a. Solvent Cement Joints:
      1) Bevel pipe ends and remove all burrs before making joints. Clean both pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40°F or above 90°F when exposed to direct sunlight or in wet conditions.
      2) Use solvent cement supplied or recommended by the pipe manufacturer.
      3) Apply joint primer and solvent cement and assemble joints in strict accordance with the recommendations and instructions of the manufacturer of the joint materials and the pipe manufacturer.
      4) Observe safety precautions with the use of joint primers and solvent cements. Allow air to circulate freely through pipelines to permit solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.

b. Push-On Joints:
   1) Bevel all field-cut pipes, remove all burrs and provide a reference mark the correct distance from the pipe end.
   2) Clean the pipe end and the bell thoroughly before making the joint. Insert the O-ring gasket, making certain it is properly oriented. Lubricate the spigot well with an approved lubricant; do not lubricate the bell or O-ring. Insert the spigot end of the pipe carefully into the bell until the reference mark on the spigot is flush with the bell.

8. Copper Tubing Joints:
   a. Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B 32.
   b. Ream or file pipe to remove burrs.
   c. Clean and polish contact surfaces of joints.
   d. Apply flux to both male and female ends.
   e. Insert end of tube into full depth of fitting socket.
   f. Heat joint evenly.
   g. Form continuous solder bead around entire circumference of joint.
   h. Runs shall contain unions at connection to equipment and at reasonable distances along the lengths of runs to permit convenient disassembly of piping and removal of equipment.
9. Mechanical Coupling Joints:
   a. Prior to the installation and assembly of mechanical couplings, the joint ends shall be cleaned thoroughly with a wire brush to remove foreign matter. Following this cleaning, lubricant shall be applied to the rubber gasket or inside of the coupling housing and to the joint ends. After lubrication, the gasket shall be installed around the joint end of the previously installed piece and the joint end of the subsequent piece shall be mated to the installed piece. The gasket shall be positioned and the coupling housing placed around the gasket and over the grooved or shouldered joint ends. The bolts shall be inserted and the nuts screwed up tightly by hand. The bolts shall then be tightened uniformly in order to produce an equal pressure on all parts of the housing. When the housing clamps meet metal to metal, the joint is complete and further tightening is not required.
10. HDPE Double Containment Pipe (Containment and Carrier Pipe):
   a. Joints of double containment piping system shall be installed in strict accordance with the manufacturer's instructions and shall be of the butt fusion process.

H. Connections to Valves and Hydrants:
   1. Install valves and hydrants as shown on the Drawings. Valves shall be located in such a way that they are accessible for repair and removal in the future.
   2. Provide suitable adapters when valves or hydrants and piping have different joint types.
   3. Provide thrust restraint at all hydrants and at valves at pipeline terminations.

I. Transitions from One Type of Pipe to Another:
   1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

J. Closures:
1. Provide all closure pieces shown on the Drawings or required to complete the Work.

3.5 BACKFILL

A. General
1. Backfill begins after the placement of the pipe bedding/granular embedment. Pipeline trenches may be backfilled prior to pressure testing, but no structure shall be constructed over any pipeline until it has been tested.
2. Place and compact backfill as construction progresses.
3. Compacted backfill shall be required for the full depth of the trench above the granular pipe embedment material. Where the trench for one pipe passes beneath the trench for another pipe or electrical duct bank, the lower trench shall be compacted to the level of the bottom of the upper trench.
4. Each layer of backfill material shall be compacted by at least two complete coverages of all portions of the surface of each lift using approved compaction equipment. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of the compacting surface of the compactor.
5. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.
6. The degree of compaction required for all types of fills shall be as listed below. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction.
7. The trench backfill shall be thoroughly compacted to no less than the following densities when tested and determined by ASSHTO T-99 and T-191 or ASTM D 2922 and D 3017. When ASSHTO T-99, Method A or B, and T-191 are used for density determination, MAG Detail 190 will be used for rock correction. The minimum density required is identified below:

8.

Material Thick. (in)	Required Minimum Density-Percent Compaction (ASTM D 698)	Maximum Uncompacted Lift (inches)
Aggregate Base Course:		
Below asphalt paving	100	8
Trench Backfill above pipe:	95	12
Granular Pipe Embedment Material:	100	6
Sand Embedment Material:	95	6

a. All fill must be wetted and thoroughly mixed to achieve optimum moisture content, ± three percent, with the following exceptions: On site clayey soils optimum to plus three percent.

b. Natural undisturbed soils or compacted soil subsequently disturbed or removed by construction operations shall be replaced with materials compacted as specified above.

3.6 GRADING

A. General: Uniformly grade areas within limits of grading shown on the Drawings or specified, including adjacent transition areas. Smooth subgrade surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown on the Drawings, or between such points and existing grades.

B. Turfed Areas: Finish areas to receive topsoil to within not more than 1-inch above or below the required subgrade elevations.

C. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1-inch above or below the required subgrade elevation.

D. Pavements: Shape surface of areas under pavements to line, grade and cross-section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

E. Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a 10-foot straightedge.

F. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density required.

3.7 PAVEMENT SUBBASE COURSE

A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
   1. Refer to Section 32 12 16, Bituminous Paving.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12-inch width of shoulder simultaneously with compacting and rolling of each layer of subbase course.

D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.

   1. When a compacted subbase course is shown on the Drawings to be 6-inches thick or less, place material in a single layer. When shown on the Drawings to be more than 6-inches thick, place material in equal layers, except no single layer more than 6-inches or less than 3-inches in thickness when compacted.

3.9 DISPOSAL OF EXCAVATED MATERIAL

A. Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away by

CONTRACTOR and disposed of in compliance with municipal, county, state, federal or other applicable regulations at no additional cost to OWNER.

3.10 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

A. Place 1-1/2 inches of temporary bituminous pavement immediately after backfilling trenches in paved roadways. Maintain the surface of the paved area over the trench in good and safe condition during progress of the entire Work, and promptly fill all depressions over and adjacent to the trench caused by settlement of backfill. Immediately prior to constructing the permanent paving and base, remove and dispose of temporary pavement. Permanent replacement pavement shall be equal to that of the existing roadways unless otherwise shown on the Drawings or specified.

B. Pavement, gutters, curbs, walks, driveways and roadways disturbed or damaged by CONTRACTOR'S operations, except areas designated "New Pavement" or "Proposed Pavement", shall be restored or replaced at CONTRACTOR'S expense to as good condition as they were previous to the commencement of the Work and in accordance with applicable local and state highway specifications.

3.11 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
   1. Locations of existing piping shown on the Drawings should be considered approximate.
   2. Determine the true location of existing piping to which connections are to be made, and location of other facilities which could be disturbed during earthwork operations, or which may be affected by CONTRACTOR'S Work already installed.
   3. Conform to applicable requirements of Division 1, General Requirements, pertaining to cutting and patching, and connections to existing facilities.

B. Taking Existing Pipelines Out of Service:
   1. Do not take pipelines out of service unless specifically listed below, or approved by ENGINEER.
      a. Refer to Section 01 14 16, Coordination With OWNER'S Operations
   2. Notify ENGINEER at least 48 hours prior to taking any pipeline out of service.

C. Work on Existing Pipelines:
   1. Cut or tap pipes as shown on the Drawings or required with machines specifically designed for this Work. All taps shall be made at the spring line except for air release taps. Taps to buried piping 16-inches in diameter and larger shall be protected by an access vault to the surface or shall be 4-inches larger, with a shut off ball valve and a riser to the surface. Taps made to pipe smaller than 16-inches may be 2-inch taps. Taps shall not be located under slabs.
   2. Install temporary plugs to prevent entry of mud, dirt, water and debris.
   3. Provide all necessary adapters, fittings, pipe and appurtenances required to complete the Work.
   4. Existing pipelines which are cut and abandoned shall be adequately capped or filled with grout.

3.12 TESTING OF PIPING

A. General:
   1. Test all piping, except as otherwise authorized by ENGINEER.
   2. Notify ENGINEER and local authorities having jurisdiction at least 48 hours in advance of testing if their presence is required.
   3. Conduct all tests in the presence of the ENGINEER.
   4. Remove or protect any pipeline-mounted devices which may be damaged by the test pressure.
   5. Provide all apparatus and services required for testing, including but not limited to, the following:
      a. Test pumps, bypass pumps, hoses, calibrated gauges, meters, test containers, valves and fittings.
      b. Temporary bulkheads, bracing, blocking and thrust restraints.
   6. Provide air if an air test is required and power if pumping is required.
   7. Unless otherwise specified, OWNER will provide fluid required for testing.
   8. Repair and retest pipelines that fail to hold specified test pressure or which exceed the allowable leakage rate.
   9. Unless otherwise noted, pipelines shall hold specified test pressure for two hours.
   10. Unless otherwise specified, test pressures required are at the lowest elevation of the pipeline section being tested.

B. Schedule of Pipeline Tests:
   1. Refer to Section 33 14 10, Piping Systems, for the type of test required and the required hydrostatic test pressure.
   2. Unless otherwise specified, the required hydrostatic test pressures are at the lowest elevation of the pipeline.
   3. For piping not listed in Section 33 14 10, Piping Systems:
      a. Hydrostatically test pipe that will be operating at a pressure greater than five psig.
      b. Use exfiltration testing or low-pressure air testing for all other piping.
   4. Hydrostatic Test Pressure:
      a. Use test pressures listed in Section 33 14 10, Piping Systems.
      b. If a test pressure is not listed in Section 33 14 10, Piping Systems, or if a hydrostatic test is required for piping not listed in Section 33 14 10, Piping Systems, the test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the AWWA Manual or Standard which applies to the piping system.

C. Hydrostatic Testing:
   1. Preparation for Testing:
      a. For plastic pipe, including fiberglass pipe, follow procedures described in Section 7 of AWWA Standard C605.
      b. For all other piping follow procedures described in AWWA Manual M9 except that the minimum wetting period required immediately prior to testing for cement-lined steel pipe and asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. A wetting

period is not required for metal pipe that is not cement-lined or for plastic pipe.

c. Ensure that adequate thrust protection is in place and that all joints are properly installed.

2. Test Procedure:
   a. Complete backfill and compaction at least to the pipe centerline before testing, unless otherwise required or approved by ENGINEER.
   b. Allow concrete for thrust blocks to reach design strength before testing.
   c. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate should not exceed one foot per second in the pipe being tested. Install corporation cocks, if necessary, to remove all air.
   d. Examine exposed joints and valves, and correct visible leakage.
   e. After the wetting period prescribed above, add fluid to pressurize line to the required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
   f. After the stabilization period, maintain test pressure for the duration specified in Section 33 14 10, Piping Systems. Add fluid to restore test pressure if pressure drops five psi below test pressure at any time during the test period.
   g. Pump from a test container to maintain test pressure. Measure the volume of fluid pumped from the container and record on the test report. Record pressure at the test pump at 15 minute intervals for the duration of the test.
3. Allowable Leakage Rates:
   a. Conduct leakage test for all liquid piping after satisfactory completion of pressure test.
   b. Allow concrete pipe to stand full of water at least 12 hours prior to starting leakage test.
   c. Maintain test pressure constantly for the minimum test period and accurately measure the amount of water which must be added to maintain the test pressure.
   d. Allowable Leakage Rates (in gallons per hour per 1,000 feet per inch diameter):
      1) DIP Push On or Mechanical Joints: 0.075.
      2) Centrifugally Cast, Fiberglass -Reinforced Polymer Mortar Pipe: 0.0.

D. Required Tests for Gravity Sewer and Storm Drains:
1. Elect to test piping, using either air or water test procedures. Notify ENGINEER, in writing, in advance of all testing, which method he plans to utilize and must follow through with the same method on all pipeline testing.
   a. Gravity sewers shall be tested with either air or water testing; however, storm drains may only be water tested.
   b. Tests shall be performed after backfilling is completed, but shall be performed before final cleanup and acceptance of Work.
   c. Tests shall be performed prior to final acceptance.
      1) Test all piping and manholes for leakage by means of the tests described below.
      2) Test to be performed between adjacent manholes or as approved by the ENGINEER.
   d. Prior to making tests, submit details of his testing procedures, with a description of methods and equipment CONTRACTOR proposes to use, to

the ENGINEER for approval. Furnish all necessary labor, equipment, water, watertight bulkheads, rodding machine, generator, pumps and all else necessary to carry out the required tests.

2. Air Test:
   a. Wet and thoroughly clean the inside of the pipe before test is performed.
   b. Insert test plugs in ends of pipe to be tested.
   c. Securely brace test plugs.
   d. Measure and record groundwater height above the pipe invert. All gage pressures in the test shall be increased by the amount of the back pressure due to groundwater submergence.
   e. Slowly fill the pipe with air to a pressure of four psig. Maintain pressure between 4 and 3.5 psig for at least two minutes for temperature stabilization.
   f. Check all plugs for tightness.
   g. With a pressure of approximately four psig in pipe, disconnect air supply.
   h. Allow pressure to decrease to 3.5 psig.
   i. When the pressure reaches 3.5 psig, record the time required to decrease to 2.5 psig using a stopwatch.
   j. The line is considered acceptable if the time for the pressure to decrease from 3.5 psig to 2.5 psig is not less than the amount shown on the following table for the respective pipe diameters.

Minimum Acceptance Times	
Pipe Diameter (Inches)	Time
6	2 min. 50 sec.
8	3 min. 50 sec.
10	4 min. 45 sec.
12	5 min. 40 sec.
14	6 min. 40 sec.
16	7 min. 5 sec.
18	7 min. 35 sec.
20	9 min. 30 sec.
21	9 min. 55 sec.
24	11 min. 20 sec.
27	12 min. 45 sec.

   k. If the leakage in the section tested exceeds the specified amount, make the necessary repairs or replacements required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirement is met.
   l. No one shall be allowed in the manhole during air testing.
3. Water Test:

a. When water test is performed for reinforced concrete pipe, the test section shall be filled with water and allowed to stand for 24 hours. The water shall then be replenished and the test performed.
b. Insert test plugs and securely brace.
c. Fill the pipe and manhole with water to provide a positive differential head on the top of the pipe at the highest point of the pipeline under test of at least the test pressure specified in Section 33 14 10, Piping Systems.
d. The amount of water added to maintain this head shall be the leakage.
e. Test for a period of at least four hours.
f. Total leakage of any section tested shall not exceed the following rates:
   1) Gravity Sewer: 0.5 gallons per hour per 100 feet of pipe per inch diameter of pipe.
   2) Storm Drains: 2.0 gallons per hour per 100 feet of pipe per inch diameter of pipe.
g. If the leakage in the section tested exceeds the specified amount, make the necessary repairs or replacements required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirements is met.
h. On steep grades it may be necessary to place plugs in the pipe between manholes to avoid excessive pressures in the pipe.

4. Visual Inspection:
   a. Prior to final acceptance, a visual inspection by ENGINEER of all appurtenant structures, (e.g., manholes, chambers, etc.), shall be required. Any visual leaks, regardless of their magnitude shall be repaired by CONTRACTOR.
5. Watertight Sewers:
   a. It is imperative that all sewers and appurtenant structures be constructed as watertight as practicable. Adhere rigidly to all requirements of the Contract Documents and follow all directions of the ENGINEER to secure a watertight sewer. If, during the Work or after its completion, any leaks are discovered, they shall be repaired in a satisfactory manner at the expense of CONTRACTOR even though the pipe and appurtenant structures may have already successfully passed the leakage tests.

E. Vertical Deflection Test for Thermoplastic Pipe:
   1. The vertical deflection test shall be conducted after the final backfill has been in place at least 30 days.
   2. Manually pull a pin-type vertical gauge mounted on a sled through the pipe. Gauge shall be set so that if vertical deflection of pipe exceeds five percent, it will stop. Excavate and reinstall all such piping. Gauge shall be as manufactured by Quality Test Products, or equal.

3.13 DISPOSAL OF WATER

A. Provide suitable means for disposal of test and flushing water so that no damage results to facilities or waterways.

B. Means of disposal of test and flushing water shall be subject to the approval of ENGINEER, local governing authorities and regulatory agencies.

C. Responsibility belongs to CONTRACTOR for any damage caused by water disposal operations.

3.14 CLEANING AND DISINFECTION

A. Cleaning:
   1. Thoroughly clean all piping and flush in a manner approved by ENGINEER, prior to placing in service.
   2. Piping 24-inches in diameter and larger shall be inspected from inside and all debris, dirt and foreign matter removed.
   3. If piping which requires disinfection has not been kept clean during storage or installation, swab each section individually before installation with a five percent hypochlorite solution, to ensure clean piping.

B. Disinfection:
   1. Disinfect all potable and finished water piping. Comply with requirements of Section 02 70 00, Diversion of Water or Sewage Flow and Dewatering, Section 22 11 16, Potable Water Piping System, and Section 22 01 10.52, Disinfection, Plumbing.
   2. A suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures will be considered for approval by the ENGINEER.
      a. Thoroughly flush piping prior to disinfection with water. For pipelines 24-inches in diameter and larger, pipelines shall be manually cleaned, carefully removing all sweepings, dirt and debris prior to disinfection.
      b. Conform to procedures described in AWWA C 651. Continuous feed method of disinfecting shall be used, unless alternative method is acceptable to ENGINEER.
   3. Water for initial flushing, testing and chlorination will be furnished by the OWNER. Provide all temporary piping, hose, valves, appurtenances and services required. Cost of water required for redisinfection will be paid by CONTRACTOR to OWNER at OWNER'S standard rates.
   4. Chlorine will be supplied by CONTRACTOR.
   5. Bacteriologic tests will be performed by OWNER. A certified test laboratory report will be made available to CONTRACTOR, if requested.
   6. Chlorine concentration in the water entering the piping shall be between 50 and 100 parts per million, such that a minimum residual concentration of 25 mg/l will be left after a 24-hour retention period. Care shall be taken to ensure disinfection of the piping in all its parts. The operation shall be repeated as necessary to provide complete disinfection.
   7. After the required retention period, the heavily chlorinated water shall be flushed to drain, unless otherwise directed by the ENGINEER.

3.15 INSTALLATION OF DETECTABLE PIPE LOCATING TAPE

A. Underground Pipe Locating Tape:
   1. Refer to paragraph 2.3.A of this Section, and Section 33 14 10, Piping Systems.
   2. Detectable pipe locating tape shall be placed above all underground pipelines. Tape shall be buried 12-inches below finished grade directly above entire pipeline length.

3. Detectable pipe locating tape for reuse water shall be buried on top and in contact with the pipe in addition to 12-inches below finished grade.

FORMULA FOR DETERMINATION
OF BURIED PIPE
HARNESSED LENGTHS

Lengths shall be based on the following:

$$\text{Harnessed Length (L) on each side of bend} = \frac{T}{f \sum W}$$

$$T = 1.25\ PA \sin \Delta/2$$

T = Thrust (lbs)

P = Test Pressure (psi), refer to Section 33 14 10, Piping Systems.

A = Pipe Area (sq.in.)

Δ = Angle of Bend

f = friction factor between soil and pipe = 0.3*

$\sum W = W_p + W_s + W_w$

W_p = weight pipe (pounds per linear foot-PLF)

W_s = weight soil (PLF)**

W_w = weight fluid (PLF)

* For ductile iron and steel pipe: friction factor = 0.1.
** Based on depth of cover on pipe, and outside diameter of pipe. Soil weight = 100 pcf.

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SECTION 33 05 17

COPPER PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install copper pipe and fittings.
   2. The extent of the piping is shown on the Drawings and Section 33 14 10, Piping Systems.
   3. All jointing materials, end caps and other appurtenances and accessories shall be provided.
   4. It is the intent of the Contract Documents to provide complete and workable piping systems. Any supplementary fittings and appurtenances required for proper completion of the Work shall be considered as having been included under this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturers of copper pipe and fittings shall have a minimum of five years of experience producing copper pipe and fittings, and shall be able to show evidence of at least five installations in satisfactory operation.

B. Requirements of Regulatory Agencies: Comply with the applicable provisions of the following regulatory agencies, where applicable:
   1. ASME, Boiler and Pressure Vessel Code.
   2. National Fire Protection Association.
   3. Underwriters' Laboratories, Incorporated.
   4. Phoenix Plumbing Code.
   5. Phoenix Building Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   2. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   3. ASTM B 32, Specification for Solder Metal.
   4. ASTM B 42, Specification for Seamless Copper Pipe, Standard Size.
   5. ASTM B 68, Specification for Seamless Copper Tube, Bright Annealed.
   6. ASTM B 75, Specification for Seamless Copper Tube.
   7. ASTM B 88, Specification for Seamless Copper Water Tube.
   8. ASTM B 280, Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service.
   9. ASTM B 302, Specification for Threadless Copper Pipe, Standard Sizes.
   10. ASTM B 306, Specification for Copper Drainage Tube (DWV).

D. Inspection: The quality of all materials provided and adequacy of installation shall be subject to the review and approval of the ENGINEER.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on pipe fittings and appurtenances. Submit these with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Potable Piping: Potable piping shall conform to the requirements of ASTM B 88. Underground, buried piping, unless otherwise specified, shall be Type K. All fittings shall be soldered, except at valves which may be flared, compression types or threaded type supplied with solder socket by threaded adaptors. Exposed piping shall be Type L, unless otherwise specified.

B. Threadless Copper Pipe: Pipe shall be assembled with brazing-joint pipe fittings. Material shall conform to ASTM B 302.

C. Copper Drainage Pipe: Pipe for sanitary drainage or soil, waste and vent pipe, shall conform to ASTM B 306.

D. High Pressure Air: Pipe for high pressure air, shall conform to the requirements of Section 22 15 13, Compressed Air Piping Systems.

E. Couplings and fittings for copper tubing:
   1. Unless otherwise specified, couplings for copper tubing 1/2-inch and smaller nominal diameter shall be compression type, bronze or brass, capable of holding the full bursting strength of the tubing and shall meet the requirements of ANSI B16.26.
   2. Product and Manufacturer: Provide fittings and couplings for copper tubing by one of the following:
      a) Swagelok.
      b) Gyrolok.
      c) Or equal.

2.2 JOINTING

A. Potable water piping shall be assembled with soldered type joints. Fittings shall conform to ANSI B16.22.

1. Soldered joints shall be 95-5 tin-antimony solder, conforming to ASTM B 32.
2. Ream or file pipe to remove burrs.
3. Clean and polish contact surfaces of joints.
4. Apply flux to both male and female ends.
5. Insert end of tube into full depth of fitting socket.
6. Heat joint evenly.
7. Form continuous solder bead around entire circumference of joint.

B. All joints shall conform to manufacturers recommendations and shall be made by skilled workmen.

C. Joints shall develop full strength and shall be greater than the pipe joined.

2.3 MARKING

A. All items shall be marked or labeled with the following information:
1. Metal or alloy designation.
2. Temper.
3. Size and schedule.
4. ASTM specification number.
5. Name and location of supplier.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 33 14 10, Piping Systems, and Section 33 05 05, Buried Piping Installation, for installation, testing and cleaning.

B. Refer to Section 33 14 10, Piping Systems, and Section 40 05 05, Exposed Piping Installation, for installation, testing and cleaning.

C. Dielectric Protection: Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to ensure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, CONTRACTOR shall provide dielectric protection as specified in Section 40 05 73.25, Piping Specialties and Accessories.

D. All copper piping being buried shall be provided with a protective covering or wrapping such as polyethylene wrap as specified in MAG Section 610.6 – Polyethylene Corrosion Protection. Tape wrapping shall be a minimum of 100-mil tape.

+ + END OF SECTION + +

SECTION 33 05 19

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish ductile iron pipe and fittings.
   2. The extent of the piping is shown on the Drawings and in Section 33 10 00, Piping Systems.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have a minimum of five years of experience producing ductile iron pipe and fittings, and shall be able to show evidence of at least five installations in satisfactory operation of similar diameters, lengths, and pipe class required for the Work.
   2. All ductile iron pressure water pipe shall be furnished by a single manufacturer and fully manufactured in the USA, including casting, testing, and all applicable linings and coatings. The supplier shall be responsible for the provisions of all test requirements specified in AWWA C151 as applicable. In addition, all ductile iron pressure water pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of plant inspection of all pipe approved for this Contract, will be borne by the OWNER.
   3. The CONTRACTOR shall be responsible for testing the corrosion monitoring and cathodic protection systems.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings.
   2. AWWA C110, Ductile Iron and Gray-Iron Fittings.
   3. AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
   4. AWWA C115, Flanged Ductile Iron Pipe with Ductile-Iron or Grey-Iron Threaded Flanges.
   5. AWWA C150, Thickness Design of Ductile Iron Pipe.
   6. AWWA C151, Ductile Iron Pipe, Centrifugally Cast.
   7. AWWA C153, Ductile-Iron Compact Fittings for Water Service.
   8. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   9. AWWA C606, Grooved and Shouldered Joints.
   10. ANSI/ASME B16.1, Grey Iron Pipe Flanges and Flanged Fittings.
   11. ANSI/ASME B18.2.1, Square, Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head and Lax Screws (Inch Series).
   12. ANSI/ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

13. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
14. ASTM A354, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit detailed drawings and data on pipe, fittings, gaskets and appurtenances as required. Refer to and comply with the requirements of Section 33 05 05, Buried Piping Installation, Section 40 05 05, Exposed Piping Installation, Section 22 05 17, Wall Pipes, Floor Pipes and Pipe Sleeves, and Section 22 05 29, Pipe Hangers and Supports.
   2. Within 14 days of the Date of Agreement, submit the name of the pipe manufacturer and a list of materials to be furnished by said manufacturer. Also, include information on local representative for manufacturer, if product is sold through a distributor.
   3. Shop Drawings shall include piping layouts and schedules. Drawings shall include dimensioning, joint details (including standard and restrained joint details) indicating all pertinent dimensions and manufacturing tolerances, methods and location of supports, anchorage, gasket material, grade of material, and all other pertinent technical information for all items to be furnished.
   4. Submit manufacturer's catalog data and descriptive literature for all material items listed below. Show dimensions and materials of construction by specification reference and grade where applicable.
      a. Polyethylene film for encasement of ductile iron.
      b. Wire.
      c. Exothermic weld kit.
      d. Weld caps.
      e. Weld coating.
   5. Qualifications of the CONTRACTOR’s Corrosion Engineer and Corrosion Technician.

B. Certificates: Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or otherwise damaged material and immediately remove from site.

F. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Joints shall be as specified in Section 33 14 10, Piping Systems. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Couplings shall be provided on pipe with plain or grooved ends where shown on the Drawings or where approved by ENGINEER. Joints for piping located in vaults and structures shall be flanged unless mechanical clamp-type couplings or flange adapters are shown on the Drawings.
   2. Ductile iron pipe shall be designed, manufactured, tested, inspected, and marked in accordance with the provisions of this Specification and AWWA C151 except as modified herein.
   3. All ductile iron pipe 16-inches and larger shall have cathodic protection. Pipelines less than 16-inches shall have cathodic protection where called for in the Drawings and specifications.

B. Ductile Iron Pipe and Fittings:
   1. Flanged Pipe: Fabricate in accordance with requirements of AWWA C115.
      a. Thickness: Wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.
   2. Non-Flanged Pipe: Conform to AWWA C151 for material, pressure, dimensions, tolerances, tests, markings and other requirements.
      a. Pressure: Pipe shall be designed to meet the testing requirements of Paragraph 3.1.C.
   3. Joints:
      a. Flanged Joints: Conform to AWWA C110, C115 and C153 capable of meeting, working and test pressure specified in Paragraph 3.1.C.
         1) Gaskets: High temperature resistant sealing compounds (Loctite PST 592) or equivalent with Dimethacrylate ester base and Teflon can be used.
            a) Gaskets: Unless otherwise specified, gasket stock shall be a synthetic rubber, 1/8-inch thick, full face, compound in which the elastomer is nitrile or neoprene. The compound shall contain not less than 50 percent by volume nitrile or neoprene and shall be free from factice, reclaimed rubber and other deleterious substances. Gaskets shall comply with AWWA C111 for push-on and mechanical joints with AWWA C606 for grooved end joints.
         2) Bolts and Nuts: Conform to ANSI B18.2.1 and ANSI B18.2.2, respectively. Exposed and buried bolts and nuts shall be ASTM A307, Grade B. Buried bolts and nuts not encased in polyethylene shall be mortar coated to a minimum thickness of 1-inch or alternately coated with a petroleum based mastic and wrapping tape system Denso Paste primer and Densyl Tape finish as manufactured by Denso, or approved equal. Submerged bolts and nuts shall be Type 316 stainless steel.
      b. Mechanical Joints: Conform to AWWA C110, AWWA C111 and C-153.

1) Glands: Ductile iron.
2) Gaskets: Plain Tip.
3) Bolts and Nuts: Conform to ANSI B18.2.1 and ANSI B18.2.2, respectively. Bolts and nuts shall be ASTM A307, Grade B. Buried bolts and nuts not encased in polyethylene shall be mortar coated to a minimum thickness of 1-inch or alternately coated with a petroleum based mastic and wrapping tape system Denso Paste primer and Densyl Tape finish as manufactured by Denso, or approved equal.

c. Push-On Joints: Conform to AWWA C111.
1) Gaskets: Molded rubber.
2) Strips: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.

d. Grooved End Joints: Conform to AWWA C606.
1) Gaskets: Flush seal type designed for ductile iron.
2) Bolts and nuts: As specified for flanged joints.
3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
4) Grooved end joints shall be as manufactured by one of the following:
a) Victaulic, Style 31
b) Or equal.
5) For grooved-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the ENGINEER.

f. Restrained Joints:
1) All pipeline valves and fittings shall have thrust blocks as shown or referenced on the drawings designed for the working pressure in addition to the restraining systems per Paragraph 2.1.B.3.f 2 and 3).
2) Restrained joints for mechanical joint piping shall be one of the following:
a) Romagrip, as manufactured by Romac Industries.
b) Megalug, Series 1100, as manufactured by EBBA Iron Sales, Inc.
c) Stargrip, Series 3000, as manufactured by Star Pipe Products
d) Uni-Flange Series 1400, as manufactured by Ford Meter Box.
3) Restrained joints for push-on joint piping shall be one of the following:
a) Clow Super-lock Joint Pipe, as manufactured by Clow Cast Iron Pipe and Foundry Division of Clow Corporation.
b) Lok-Ring Joint, or Flex-Ring Joint, as manufactured by American Cast Iron Pipe Company.
c) TR Flex Joint, as manufactured by U.S. Pipe.
d) Thrust-lock, as manufactured by Pacific States Pipe.
e) Snap-Lok or Bolt-Lok, as manufactured by Griffin Pipe.
4) Split restrained joint glands for mechanical joints, or wedge action restrained joint glands for push (non-mechanical) joints, are only allowed for connection or repair to existing installed pipe. The split restrained joint or wedge glands shall be one of the following:
a) Stargrip Series 3000S, 3100P, 3100S, as manufactured by Star Pipe Products
b) Megalug Series 1100SD, 1100H D, as manufactured by EBAA Iron Sales, Inc.

c) Megalug Series 1700, as manufactured by EBAA Iron Sales, Inc.
d) Uni-Flange Series 1450, as manufactured by Ford Meter Box

4. Flanged fittings: Conform to AWWA C110 and AWWA C115. AWWA C153 compact ductile iron fittings are acceptable for use unless otherwise specified. Long-radius elbows shall be provided where specified.
   a. Pressure Rating: 150 psi.
   b. Material: Ductile iron.
   c. Gaskets: As specified above for joints.
   d. Bolts and Nuts: As specified above for joints.

5. Mechanical Joint Fittings: Conform to AWWA C110. AWWA C153 compact ductile iron fittings are acceptable for use unless otherwise specified. Long-radius elbows shall be provided where specified.
   a. Pressure Rating: 250 psi.
   b. Material: Ductile iron.
   c. Glands: Use ductile iron glands only. Cast iron glands are not allowed.
   d. Gaskets: As specified above for joints.
   e. Bolts and Nuts: As specified above for joints.
   f. Mechanical Joint Bolt Holes: Orient bolt holes to straddle vertical centerline of the following fittings.

6. Coatings and Linings:
   a. Unless otherwise specified, pipe and fittings shall be lined with a cement-mortar lining in accordance with AWWA C104.
   b. Where specified in Section 33 14 10, Piping Systems, glass-lined pipe shall be provided in accordance with Section 33 05 19.11, Glass Lined Ductile Iron Pipe.
   c. Buried pipe and fittings shall be coated on the outside with a bituminous coating, approximately 1-mil thick material as specified in AWWA C151. Buried flanged joints shall be coated with a petroleum based mastic and wrapping tape system Denso Paste primer and Densyl Tape finish as manufactured by Denso, or approved equal. Exposed pipe shall be prime coated in accordance with Section 09 90 00, Painting and Coating.
   d. Polyethylene Encasement:
      1) All polyethylene film shall be manufactured in accordance with ANSI/AWWA C105/A21.5.
      2) All open cut installed buried pipe shall be provided with polyethylene encasement to prevent contact between the pipe and surrounding bedding material and backfill.
      3) Polyethylene may be supplied in tubes or in sheet material.

7. Epoxy Lining Material: Where specified in Section 33 14 10, Piping Systems, epoxy lining shall be provided. The material shall be an amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment. Epoxy lining material manufacturer shall demonstrate a successful history of lining pipe and fittings for sewer service and submit a test report verifying the following properties, and a certification of the test results.
   a. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
   b. The following test shall be run on coupons from factory lined ductile iron pipe:

1) ASTM B-117 Salt Spray (scribed panel): Results to equal 0.0 undercutting after two years.
2) ASTM G-95 Cathodic Disbondment 1.5 volts at 77°F: Results to equal no more than 0.5 mm undercutting after 30 days.
3) Immersion Testing rated using ASTM D-714-87.
   a) 20 percent Sulfuric Acid: No effect after two years.
   b) 25 percent Sodium Hydroxide: No effect after two years.
   c) 160°F Distilled Water: No effect after two years.
   d) 120°F Tap Water (Scribed panel): 0.0 undercutting after two years with no effect.

c. An abrasion resistance of no more than four mils loss after one million cycles - European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.
d. Interior of the pipe shall receive 40 mils dry film thickness.
e. Applicator: The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
f. Surface Preparation: Pipe surfaces shall be cleaned and sand blasted prior to lining application in accordance with manufacturer's recommended procedures.
g. Inspection and Certification:
   1) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.
   2) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.
   3) The pipe or fitting manufacturer shall supply a certificate attesting to the fact that the applicator met the requirements of this specification.
h. Product and Manufacturer: Provide one of the following:
   1) Protecto 401.
   2) Or equal.

8. Bonded Joints:
   a. All pipes 16 inches and larger shall have bonded joints.
   b. Joint Bond Wires: Bond wires shall be provided across all non-conductive ductile iron pipe joints to ensure electrical continuity. Joint bonds shall be installed as shown on the drawings.
   c. Joint bonds shall be made utilizing #4 AWG type HMWPE stranded conductors. Bond wires shall not exceed 18 inches in length. Connections shall be made utilizing the exothermic weld process as described below.
   d. Exothermic Welds: Exothermic welds shall be provided for wire to structure connections in strict accordance with the manufacturers recommendations. Connections shall be made at locations shown on drawings. Exothermic welds shall be "Cadweld", as manufactured by Erico Products, Inc., "Thermoweld" as manufactured by Continental Industries, Inc., "Pin Brazing" by BAC, or approved equal. Duxseal packing as manufactured by Johns-Manville or approved equal shall be used where necessary to prevent leakage of molten weld metal.
   e. The shape and charge of the exothermic weld shall be chosen based on the following parameters:
      1) Pipe Material
      2) Pipe Size
      3) Wire Material
      4) Number of Strands to be Welded

5) Orientation of Weld (Vertical or Horizontal)

f. Type of exothermic weld to be used shall be submitted to the Construction Manager for approval.

g. Copper sleeves specifically designed for the purpose shall be crimped on all bare wire ends of all stranded wires prior to exothermic welding to improve mechanical strength and thermal capacity.

h. Weld Caps: Welds to be buried or submerged shall be primed with an elastomer resin based primer then be covered with a 100% solids mastic filled plastic cap. Use the plastic cap on dielectric coated pipe following the manufacturer's instructions. Primer shall be Roybond Primer 747 as manufactured by Royston Laboratories, or equivalent. Weld caps shall be Royston Handy Cap, as manufactured by Royston Laboratories, Inc. Thermit Weld Cap, as manufactured by Phillips Petroleum Co. or pre-approved equal.

C. Couplings:
1. Refer to Section 40 05 73.25,Piping Specialties and Accessories.

D. Specials:
1. Transition Pieces:
   a. Furnish suitable transition pieces (adapters) for connections to existing piping.
   b. Unless shown on Drawings, expose existing piping to determine material, dimensions and other data required for transition pieces.
2. Taps:
   a. Provide taps where shown on the Drawings or required for small diameter pipe connections.
   b. Provide a tapping saddle conforming to the requirements of the City of Phoenix Water Services Department. Tapping saddles shall have a maximum outlet diameter of 3”.
3. Welded Outlets:
   a. Provide welded outlet fittings as shown on the Drawings.
   b. Welded-on outlets shall be limited to branch or radial outlets.
   c. Welded-on outlets may be provided as a radial (tee) outlet, or lateral outlet fabricated at a specific angle to the main line pipe, as indicated on the drawings.
   d. Outlets greater than fifty percent (50%) of the nominal diameter of the main line pipe or 12-inch, which ever is smaller, shall be an integral tee fitting.
   e. Welded outlets for ductile iron pipe are not acceptable for a tangential configuration unless shown on the plans or approved by the ENGINEER.
   f. No welding shall be permitted within 24-inches from the end of the pipe. Spacing of welded outlets shall not be closer than two times the diameter of the largest outlet.
   g. The pipe manufacturer or fabricator performing the welds shall have a minimum of 5 years experience in the fabrication and testing of outlets of similar size and configuration.
   h. The joints on welded-on branch outlets shall meet, where applicable, the requirements of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15.
   i. Design
      1) Weldment for welded-on outlets shall be based on the method described in Section VIII of the ASME Unfired Pressure Vessel Code. Reinforcing welds shall be placed using Ni-Rod FC 55o cored wire or Ni-Rod 55o electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties). Carbon Steel electrodes are not acceptable. 2) Parent pipe and branch outlet pipe shall be centrifugally cast ductile iron pipe designed in

accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with NSI/AWWA C151/A21.51. Minimum classes shall be: for sizes 4-inch through 54-inch, Special Thickness Class 53; for sizes 60-inch through 64-inch, Pressure Class 350.

2) Welded outlets require submittal and approval of design calculations, welding procedures, and actual structural testing results for both hydrostatic pressure as well as transverse and axial loading imposed on the outlet itself.

j. Testing
   1) All welded-on outlets shall be rated for a working pressure of 250 psi and must have a minimum safety factor of 2.0 based on proof of design hydrostatic test results. The manufacturer shall, at the request of the owner or owner's Engineer, provide representative proof test data confirming hydrostatic test results and safety factors.
   2) Prior to the application of any coating or lining in the outlet area all weldments for branch outlets to be supplied on this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. Any leakage shall be detected by applying an appropriate soapy water solution to the entire exterior surface of the weldment and adjoining pipe edges or by immersing the entire area in a vessel of water and visually inspecting the weld surface for the presence of air bubbles. Any weldment that shows signs of visible leakage shall be repaired and retested in accordance with the manufacturer's written procedures.

k. Quality Assurance:
   1) The manufacturer shall have a fully documented welding quality assurance system and maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall maintain appropriate welding procedure specification (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records as well as appropriate air test logs documenting air leakage tests. The manufacturer shall have ISO 9001 or 9002 registration.
   2) Prior to the start of manufacturing any proposed manufacturer not meeting ISO 9001 or 9002 registration requirements shall submit to the owner or owner's Engineer the name of an Independent Inspection Agency and the agency's qualifications. Submitted qualifications shall include but are not limited to the following:
      a) List of project references for projects of similar type and size
      b) Resumes for inspection and testing personnel
      c) Capacities for chemical and mechanical testing of material specimens
      d) Frequencies for all instrument and testing equipment certifications
   3) The independent inspection agency shall be responsible for all of the following:
      a) Verify compliance to written welding procedures specification (WPS) and procedure qualification (PQR)
      b) Verify qualification of all welders (WPQR) per ANSI/AWS D11.2 criteria
      c) Document use of Ni-Rod FC 55o cored wire or Ni-Rod 55o electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties)
      d) Witness and document all air testing of outlet welds

l. Field Welding: No field welding or field repairs shall be allowed. Should a leak be detected at a welded-on outlet after installation, the piece shall be removed and

returned to the pipe manufacturer's facility, where originally produced, for repair or replacement.

2.2 MARKING FOR IDENTIFICATION

A. All pipeline materials shall be stamped, marked or identified with the following:
   1. Name or trade mark of the manufacturer.
   2. Pipe class.
   3. Size and length dimensions.
   4. Date and place of manufacture.

B. Plastic Tracer Tape: Tracer tape shall be 6-inches wide, colored the same as the background colors as specified in Section 09 90 00, Painting and Coating, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

C. Two messages shall be printed on the tape. The first message shall read "CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW" with bold letters approximately 2-inches high. The blank shall be filled with the particular system fluid such as potable water. The second message shall read, "CALL ____" with letters approximately 3/4-inch high. The blank shall be filled in with the City telephone number. Both messages shall be printed at maximum intervals of two feet.

2.3 SURFACE PREPARATION AND SHOP PAINTING

A. Exposed pipe and fittings:
   1. Clean and prime coat ferrous metal surfaces of piping in the shop in accordance with the requirements of Section 09 90 00, Painting and Coating.
   2. Field painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

B. Buried pipe and fittings:
   1. Refer to Paragraph 2.1.B.6.c., above.

PART 3 - EXECUTION

3.1 INSTALLATION

A. For buried piping installation and testing, refer to Section 33 14 10, Piping Systems, and Section 33 05 05, Buried Piping Installation.

B. For exposed piping installation and testing, refer to Section 33 14 10, Piping Systems, and Section 40 05 05, Exposed Piping Installation.

C. Testing
   1. General:
      a. The CONTRACTOR shall test waterlines for water tightness, including all fittings and connections to the waterlines. Each pipe shall be tested for leakage and

pressure in accordance with applicable provisions of AWWA standards and/or Manuals, except as modified below.

b. The CONTRACTOR shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, including measuring device and all other equipment necessary for making the tests, except pressure gages. CONTRACTOR shall furnish all labor and material, and all water required for pressure testing and obtain all permits for test water discharge at no additional cost to the Owner. All water must be dechlorinated to negligible levels prior to discharge to any location. All test water shall be potable. No other water shall be allowed in the pipe.

c. The pipe shall be tested between the closed ends of the pipe. There shall be no testing against a valve unless otherwise approved. Pipe test section shall be limited to 2,500 linear feet, or less, unless otherwise approved in writing by the Engineer. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained a strength of 3000 psi. The CONTRACTOR shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment.

d. The test shall be made after the backfilling is completed and compacted, regardless of the compaction method.

e. All connections, blowoffs, hydrants and valves shall be tested with the main, where practical.

f. The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as approved by the Superintendent of Water Distribution, with at least 24-hour notice required before filling is scheduled.

g. Connections to existing pipelines or existing valves shall be made after new construction has satisfactorily passed the pressure and leakage tests and potable water piping has been flushed and disinfected in accordance with AWWA C651.

2. Pressure Test

a. Waterlines, including all fitting and connections shall be tested for water tightness by subjecting each test section to pressure test. The test pressure shall be measured at the lowest end of the test section. The test pressure shall be 188 psi unless otherwise specified. The duration of each pressure test shall be at least 2 hours. The pressure test shall begin after the pipe has been filled with water for a minimum of 48 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

b. Makeup water can be added to the pipeline to maintain test pressure. The amount of make-up water does not indicate a pass or fail of the pressure test. Satisfactory test results shall be per Paragraph 3.1.C.2.c.

c. Satisfactory test results are achieved if the test pressure is maintained within 5 psi of the required test pressure for the duration of the 2-hour test.

3. Leakage Test

a. Leakage tests shall be made after pressure test has been completed and pressure test results are satisfactory.

b. The duration of each leakage test shall be at least 2 hours. Leakage test pressure shall be a minimum of 150 psi unless otherwise indicated and the test pressure shall be maintained within 5 psi of the specified leakage test pressure during the test. Water may be continually fed or added when the pressure drops 5 psi.

c. The maximum allowable leakage from the pipe line shall be determined by the applicable formula:

$$L = \frac{ND\sqrt{P}}{7400}$$

in which:

L = allowable leakage in gallons per hour

N = number of joints in the main run pipe being tested, with no allowance for joints at branches, blowoff, fittings, and similar appurtenances. "N" is calculated using the standard length of pipe installed divided into the length being tested.

D = nominal inside diameter of pipe in inches.

P = average test pressure, in psi gage, as measured at the lowest point in the test section.

d. Should the test on any section of the pipeline show leakage greater than specified above, the CONTRACTOR shall locate and correct until the leakage is within the specified allowance for a 2-hour duration. All repairs and retests shall be at the CONTRACTOR's expense.

e. Leakage is defined as the quantity of make-up water necessary for the test section to maintain the specified leakage test pressure after the pipeline has been filled with water and all air expelled.

4. Cleaning and Flushing: Cleaning and flushing shall be per Section 33 14 10-3.6.

D. Polyethylene Encasement:
1. Encase all ductile iron pipe with polyethylene in accordance with ANSI/AWWA C105/A21.5.
2. Repair any rips, punctures or other damage to the tube with the adhesive tape or pieces of tube material secured with tape.

3.2 PIPING IDENTIFICATION

A. Pipe Coding: After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with painted bonding and lettering as specified in Paragraph 2.2, above. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 25-foot centers.

B. Plastic Tracer Tape: A single line of tape as specified in Paragraph 2.2.B., above, shall be provided 2.5 feet above the centerline of buried ferrous pipe. For pipelines buried eight feet or greater below finished grade, provide a second line of tape 12-inches below finished grade,

above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

3.3 BONDED JOINTS

A. Description: Upon completion of installation of all components as shown on the drawings and in accordance with these specifications, testing shall be performed to demonstrate that the installation has been completed and is in working order in conformance with the drawings and specifications. In no case shall the testing be less than those tests outlined herein unless requested in writing by the CONTRACTOR and approved by the ENGINEER. The testing described herein shall be in addition to and not a substitution for any required testing of individual items at the manufacturers' plant. The CONTRACTOR shall provide testing of the system. The test data shall be submitted to the ENGINEER for acceptance to demonstrate that the system is in proper working order. The cost of the testing shall be borne by the CONTRACTOR, including any additional expenses which result from retesting due to equipment or installation which is not in conformance with these specifications and drawings.

B. Joint Bond Wires: Joint bond wires shall be installed as shown on the drawings. Make connections by the exothermic weld process per 3.3.C. After installation, all joint bonds shall be tested for effectiveness. The testing shall be performed prior to backfill of the pipe and shall be verified upon completion of backfilling operations. Prior to backfilling, current shall be circulated through the pipe and the measured resistance shall be compared to the theoretical resistance of the pipe and bond wires. The resistance measured shall not exceed 120 percent of the theoretical resistance. Once backfilling operations have been completed, the testing shall be repeated to ensure continued effective continuity. All data shall be tabulated and submitted upon completion of testing and prior to final acceptance of the contract.

C. Exothermic Welds: Exothermic weld connections shall be installed in the manner and at the locations shown on the plans. Coating materials shall be removed from the surface over an area of sufficient size to make the connection. The steel surface shall be cleaned to shiny metal by grinding or filing prior to welding the conductor. The use of resin impregnated grinding wheels will not be allowed. The conductor shall be welded to the pipe by the exothermic welding process with a copper sleeve fitted over the conductor. Only enough insulation shall be removed such that the copper conductor can be placed in the welding mold. After the weld has cooled, all slag shall be removed and the metallurgical bond shall be tested for adherence to the pipe or casing. All defective welds shall be removed and replaced. All exposed surfaces of the copper and steel shall be covered with insulating materials as shown in the detail drawings. No connections to the piping shall be buried prior to inspection and approval of the Engineer. Connections made in violation of this requirement shall be rejected.

D. Welds shall be primed with an elastomer resin based primer, covered with a weld cap, and then over-coated with bitumastic.

E. Exothermic welds shall be tested by the CONTRACTOR for adherence to the pipe or casing and for electrical continuity between the pipe or casing and wires. Test completed weld by striking weld with a hammer and pulling on wire. A 22-ounce hammer shall be used for

adherence testing by striking a blow to the weld. Care shall be taken to avoid hitting the wires.

3.4 INSPECTION

A. Inspect all piping to assure that piping is free from defects in material and workmanship. The compatibility of all pipe, fittings, gaskets and coatings shall be verified.

+ + END OF SECTION + +

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SECTION 33 05 31

THERMOPLASTIC PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install and place in satisfactory service chlorinated polyvinyl chloride (CPVC) and polyvinyl chloride (PVC) piping, fittings and specials.
   2. The extent of piping is shown on the Drawings and Section 33 14 10, Piping Systems.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturers of thermoplastic pipe and fittings shall have a minimum of five years of experience producing thermoplastic pipe and fittings, and shall be able to show evidence of at least five installations in satisfactory operation.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM D 1598, Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
   2. ASTM D 1599, Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.
   3. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Com-pounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   4. ASTM D 2122, Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
   5. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
   6. ASTM D 2846, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
   7. ASTM D 3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   8. ASTM F 437, Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
   9. ASTM F 439, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
   10. ASTM F 441, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
   11. ASTM F 477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

12. ASTM F 493, Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
13. Standard No. 14, National Sanitation Foundation.
14. American National Standards Institute.
15. Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

C. Shop Tests:
1. Piping manufacturer shall maintain a continuous quality control program. All CPVC plastic molding materials used to manufacture pipe and fittings under this Section shall be tested for conformance to the requirements of ASTM D 1784.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Detailed procedures to be used in jointing and installing piping system including manufacturer's recommendations.
2. Interfacing of piping system to equipment and appurtenances.
3. Detail requirements for burial, supports, anchors, guides, expansion joints, and all accessories required for a satisfactory piping system.
4. Bill of materials, indicating material composition of pipe, fittings and solvent, pressure rating, nominal size and its location on the piping installation drawings.
5. Certifications letter from pipe manufacturer confirming that the materials to be used are suitable for the intended service.

B. Certificates: Submit certificates of compliance with referenced standards.
1. Submit Certificate of Compliance with NSF.ANSI 61 Standard or with Arizona Administrative Code R18-4-119, in accordance with Section 11 00 00 Requirements.

1.4 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery: All necessary precautions shall be taken to prevent damage to pipe fittings and other materials during shipment and delivery. All materials shall be securely fastened to truck or rail car to prevent movement or damage during shipment. All materials shall be inspected by CONTRACTOR, upon delivery to the site.

B. Handling: All pipe materials shall be handled to prevent damage. Pipe and fittings shall not be dropped, rolled, or pushed off from any height on delivery, storage or installation.

C. Storage: All pipe materials shall be stored off the ground. Pipe ends shall be secured by caps or plugs. Do not store pipe or fittings in sunlight. Pipe shall be stored to prevent sagging or bending. Store off the ground, under cover, and in a dry location.

PART 2 - PRODUCTS

2.1 MATERIALS

A. CPVC Pipe:
   1. CPVC pipe shall be Schedule 80, Class 23447-B, conforming to ASTM D 1784 and ASTM F 441.
   2. Fittings shall be Schedule 80, solvent welded, socket type, conforming to ASTM F 439. Solvent cement shall conform to requirements of ASTM F 493.
   3. Provide flanged fittings at all valves and equipment with Teflon gaskets, unless shown otherwise on the Drawings. Provide Type 316 stainless steel bolts and nuts.

B. PVC Gravity Sewer Pipe:
   1. Pipe and fittings shall conform to requirements of ASTM D1784, Class 12454-B and ASTM D 3034, SDR 26. Elastomeric gaskets for joints shall conform to requirements of ASTM F 477.

C. Couplings:
   1. Type: Quick-connect, male adapter with treaded ends for permanent pipe installation, hose shank coupler for hose connection.
   2. Materials:
      a. Body: Polypropylene.
      b. Cam Arms: Stainless steel.
      c. Gaskets: Viton or EPDM.
      d. Ends: As specified above.
   3. Each adapter provided shall be equipped with adapter cap constructed of same materials.
   4. Product and Manufacturer: Provide one of the following:
      a. Plastic Piping System, Inc.
      b. Or equal.
   5. Hose:
      a. Material of Construction: Cross-linked polyethylene tube, non-staining, with neoprene cover.
      b. Temperature Rating: Up to 150°F.
      c. Hose shall be high tensile, horizontal textile braid with helix wire reinforcements.
      d. Each hose shall be fitted with hose shank coupler.
      e. Product and Manufacturer: Provide one of the following:
         1) Goodyear Rubber Company.
         2) Or equal.

D. Provide expansion compensation in accordance with the requirements of Section 22 05 29, Pipe Hangers and Supports

E. Supply type, grade and strength of pipe required to meet the specified service conditions. Submit to ENGINEER for approval.

F. Painting shall conform to requirements of Section 09 90 00, Painting and Coating.

2.2 DETAILED REQUIREMENTS

A. Workmanship: The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other defects. The pipe shall be uniform in color, opacity, density, and other physical properties.

B. Dimensions and Tolerances: Dimensions and tolerances shall be measured in accordance with ASTM D 2122. The eccentricity of the inside and outside circumferences of the pipe walls shall not exceed 12 percent.

C. Sustained Pressure: The pipe shall not fail, balloon, burst, or weep as defined in ASTM D 1598.

D. Burst Pressure: The minimum burst pressure shall be determined in accordance with ASTM D 1599.

E. Marking: Marking on the pipe shall include the following, spaced at intervals of not more than five feet.
   1. Pipe nominal size.
   2. Pipe schedule.
   3. Specification of plastic material.
   4. Type and grade of plastic.
   5. Date and place of manufacture.

F. Piping and fittings shall be manufactured with a minimum of two percent of titanium oxide for ultraviolet protection.

2.3 ADAPTERS

A. Where required to join piping of different materials, provide the required adapters, as recommended by the thermoplastic pipe manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Refer to Section 33 14 10, Piping Systems, Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, for piping installation, testing, cleaning and acceptance.
   2. Request instructions from ENGINEER before proceeding if there is a conflict between Contract Documents and manufacturer's recommendations.
   3. Pipe, fittings and accessories that are cracked, damaged, not identified or in poor condition will be rejected.

+ + END OF SECTION + +

SECTION 33 14 10

PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section specifies systems of process piping and general requirements for piping systems. Detailed Specifications for the components listed on the Piping System Specification Sheets are found in the applicable Sections of Divisions 22, 23, 33, 40 and 43. This Section shall be used in conjunction with those Sections.
   2. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish, install and test all piping, fittings and specials. The Work includes, but is not limited to, the following:
      a. All types and sizes of piping, except those specified under other Sections.
      b. Piping beneath, embedded or within structures.
      c. Supports, restraints and thrust blocks.
      d. Pipe encasements.
      e. Work on or affecting existing piping.
      f. Testing.
      g. Cleaning and disinfecting.
      h. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods and all other Work required to complete the piping installation.
         1) Gasket materials shall comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01 42 00 – References.
      i. Incorporation of valves, meters and special items shown on the Drawings and Specifications.
      j. Unless otherwise specifically shown on the Drawings, specified, or included under other Sections, all buried piping Work required begins at the outside face of structures or structure foundations and extending away from structure.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

C. Definitions:
   1. Pressure terms used in this Section are defined as follows:
      a. Maximum: The greatest continuous pressure at which piping system operates.
      b. Test: The hydrostatic pressure used to determine system acceptance.

1.2 QUALITY ASSURANCE

A. Conform to all applicable requirements of Parts 600 and 700 of the Uniform Standard specifications for Public Work Construction by the Maricopa Association of Governments (MAG). If there is a conflict between MAG Standard specifications and these Specifications, the Provisions of these Specifications shall govern.

B. Requirements of Regulatory Agencies:
   1. Comply with requirements of NFPA Standard No. 24 for "Outside Protection" where applicable to water pipe systems used for fire protection.
   2. Comply with applicable requirements of NFPA Standard No. 14 for "Standpipe and Hose Systems" used for fire protection.
   3. Comply with requirements of UL, FM and other jurisdictional authorities, where applicable.
   4. Refer to the General and Supplementary Conditions regarding permit requirements for this Work.
   5. Comply with requirements of Phoenix Construction Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. AASHTO M36/M36M, Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.
   2. ANSI A13.1, Scheme for the Identification of Piping Systems.
   3. ANSI B1.20.1, Pipe Threads, General Purpose (Inch).
   4. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
   5. ANSI B16.3, Malleable Iron Threaded Fittings Class 150 and 300.
   6. ANSI B16.5, Pipe Flanges and Flanged Fittings.
   7. ANSI B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
   8. ANSI B16.11, Forged Steel Fittings, Socket Welding and Threaded.
   9. ANSI B16.12, Cast Iron Threaded Drainage Fittings.
   10. ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   11. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   12. ANSI B31.1, Power Piping.
   13. ANSI B31.3, Chemical Plant and Petroleum Refinery Piping.
   14. ASME SECTION IX, Boiler and Pressure Vessel Code; Welding and Brazing Qualifications.
   15. ASTM A 47, Specification for Ferritic Malleable Iron Castings.
   16. ASTM A 53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
   17. ASTM A 74, Specification for Cast Iron Soil Pipe and Fittings.
   18. ASTM A 105/A105M, Specification for Carbon Steel Forgings for Piping Components.
   19. ASTM A 106, Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   20. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   21. ASTM A 197, Specification for Cupola Malleable Iron.
   22. ASTM A 234/A234M, Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

23. ASTM A 312/A312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
24. ASTM A 403/A403M, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
25. ASTM A 536, Specification for Ductile Iron Castings.
26. ASTM A 570/A570M, Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
27. ASTM B 88, Specification for Seamless Copper Water Tube.
28. ASTM C 76, Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
29. ASTM C 296, Specification for Asbestos-Cement Pressure Pipe.
30. ASTM C 443-REV A, Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
31. ASTM C 564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
32. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
33. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
34. ASTM D 2241, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
35. ASTM D 2513, Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
36. ASTM D 2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
37. ASTM D 2996, Specification for Filament-Wound Reinforced Thermosetting Resin Pipe.
38. ASTM D 3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
39. ASTM D 3261, Specification for Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
40. ASTM D 3262, Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
41. ASTM D 4174, Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems.
42. ASTM D 4101, Specification for Propylene Plastic Injection and Extrusion Materials.
43. ASTM F 441, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
44. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
45. AWWA C110, Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids.
46. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
47. AWWA C115, Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.
48. AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
49. AWWA C200, Steel Water Pipe 6 Inches and Larger.
50. AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied.

51. AWWA C206, Field Welding of Steel Water Pipe.
52. AWWA C207, Steel Pipe Flanges for Waterworks Services--Sizes 4 In. through 144 In.
53. AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings.
54. AWWA C209, Cold-Applied Tape Coating for special sections, Connections, and Fittings for Steel Water Pipelines.
55. AWWA C210, Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe.
56. AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
57. AWWA C301, Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids.
58. AWWA C303, Reinforced Concrete Pressure Pipe-Steel Cylinder Type, Pretensioned, for Water and Other Liquids.
59. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
60. AWWA C651, Disinfecting Water Mains.
61. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water.
62. AWWA M11, Steel Pipe-A Guide for Design and Installation.
63. CISPI 301, specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings.
64. FEDSPEC L-C-530B(1), Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy.
65. MIL-H-13528B, Hydrochloric Acid, Inhibited, Rust Removing.
66. MIL-STD-810C, Environmental Test Methods.
67. SAE J1227, Assessing Cleanliness of Hydraulic Fluid Power Components and Systems.
68. Phoenix Plumbing Code.
69. Phoenix Construction Code.
70. National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01 42 00 – References.

D. Fitting and Coupling Compatibility:
   1. To assure uniformity and compatibility of piping components, fittings and couplings for grooved end piping systems shall be furnished by the same manufacturers.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on pipe, fittings, gaskets and appurtenances. Submit these with Shop Drawings required under Section 33 14 10, Piping Systems, Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Certificates: Submit certificates of compliance with Referenced Standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General:
   1. Deliver materials to the site to ensure uninterrupted progress of the Work.

2. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.
3. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.
4. Unload pipe, fittings and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.
5. Inspect delivered pipe for cracked, gouged, chipped, dented or other damaged material and immediately remove defective pipe from site.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the Piping System Specification Sheets. Piping materials shall conform to detailed Specifications for each type of pipe and piping appurtenances specified in the applicable Sections.

B. Materials or products which can contact drinking water as part of a water treatment process or water supply system including but not limited to pipe, gaskets, fittings, linings, coatings, etc., must comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01 42 00 – References.

2.2 PIPING IDENTIFICATION

A. Marking Piping:
1. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
2. Cast or paint material, type and pressure designation on each piece of pipe or fitting 4-inches in diameter and larger.
3. Pipe and fittings smaller than 4-inches in diameter shall be clearly marked by manufacturer as to material, type and rating.
4. Markers bearing the legends on the background colors specified in Section 09 90 00, Painting and Coating, and shall be provided in the following letter heights:

Outside Pipe Diameter,[a] (inches)	Letter Height, (inches)
Less than 1-1/2	1/2
1-1/2 through 3	1-1/8
Greater than 3	2-1/4

a) Outside pipe diameter shall include insulation and jacketing.

5. In addition, pipe markers shall include uni- and bi-directional arrows in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. Plastic Tracer Tape: Tracer tape shall be 6-inches wide, colored the same as the background colors as specified in Section 09 90 00, Painting and Coating, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

C. Two messages shall be printed on the tape. The first message shall read "CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW" with bold letters approximately 2-inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read, "CALL _____" with letters approximately 3/4-inch high. The blank shall be filled in with the plant telephone number 602-261-800. Both messages shall be printed at maximum intervals of two feet.

D. Magnetic Tracer Tape: Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W.H. Brady Co., Seton Name Plate Corporation, Marking Services, Inc., or equal. Tape shall be acid and alkali-resistant, 3-inches wide, 0.005-inch thick, and have 1500-psi strength and 140 percent elongation value. The tape shall be colored the same as the background colors as specified in Section 09 90 00, Painting and Coating, and shall be inscribed with the word "CAUTION – PIPE BURIED BELOW" and the name of the piping system.

2.3 VALVES

A. Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non-asbestos material. Actual length of valves shall be within 1/16-inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111 and conform to the requirements of Section 33 05 05, Buried Piping Installation.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Location:
1. Piping shall be provided as specified, except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction.

B. Piping Sizes:
1. Where the size of piping is not shown on the Drawings or specified, provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than 1-inch in diameter) required for services not described by UPC shall be 1/2-inch.

C. Pipe Support, Anchorage and Seismic Bracing:
   1. Piping shall be supported by anchor brackets, guides, saddles or hangers. Acceptable types of supports, guides, saddles, hangers and structure attachments for general pipe support, expansion/contraction and for seismic bracing, as well as anchorage details, are shown on the Drawings. Minimum spacing shall be as specified for supports and for seismic bracing. Where a specific type of support or anchorage is shown on the Drawings, then only that type shall be used there. Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced where indicated to resist lateral load. Supports shall be provided on each run at each change of direction. Pipe supports, components and hardware shall be Type 304L stainless steel. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
   2. Pipe shall be supported, alignment and installed in such a way so as not to impose undue stress/forces to couplings, connections, supports, valves, equipment and instruments.

D. Thrust Restraint:
   1. General: All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.
   2. Restrained Pipe Joints: Pipe joints shall be restrained by means suitable to the type of pipe being installed.
      a. Ductile-iron push on joints and mechanical joints shall be restrained utilizing a proprietary restrained joint system such as:
         1) American Loc-Ring or Flex-Ring
         2) Clow Super-Lock Joint
         3) EBBA Iron Sales Inc. Megalug
         4) U.S. Pipe TR Flex Joint
         5) Or Equal
      b. Thermoplastic and copper piping shall generally be installed with soldered, solvent weld, threaded, flanged, or similar type joints. Where push-on type or other non-restrained joints are provided, provide tie rods or other suitable joint restraint system for these joints, subject to the approval of ENGINEER.
      c. Harnessed lengths for pipe shall be determined by the pipe manufacturer in accordance with the formula in Section 33 05 05, Buried Piping Installation, for determination of harnessed lengths.
      d. Restrain ductile iron pipe connected to flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
   3. Concrete Thrust Blocks and Anchor Blocks:
      a. Thrust blocks and anchors shall be constructed of Class B concrete.
      b. Blocks shall be placed against undisturbed soil and sized as shown on the Drawings or as directed by the ENGINEER. Concrete shall be placed so that pipe joints and fitting joints will be accessible for repair.

E. Manufacturer's Installation Specialist:
   1. Provide the services of a competent installation specialist of the pipe manufacturer when pipe laying begins, if CONTRACTOR is not experienced in laying and jointing a particular type of pipe.

2. Retain installation specialist at the site for a minimum of two days or until competency of the pipe laying crew has been satisfactorily demonstrated.

F. Bedding and Backfill:
1. Bedding and backfill for buried piping shall conform to the requirements of Section 33 05 05, Buried Piping Installation.

3.2 PIPING IDENTIFICATION

A. Pipe Coding:
1. After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with painted bonding and lettering as specified in Article 2.2, above. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 25-foot centers.

B. Plastic Tracer Tape:
1. A single line of tape as specified in Paragraph 2.2.B., above, shall be provided 2.5 feet above the centerline of buried ferrous pipe. For pipelines buried eight feet or greater below finished grade, provide a second line of tape 12-inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. Magnetic Tracer Tape: Polyethylene magnetic tracer tape shall be buried 12 to 18-inches below finished grade and shall be above and parallel to buried non-ferrous, plastic and reinforced thermosetting resin pipe lines. For pipelines buried eight feet or greater below finished grade, provide a second line of tape 2.5 feet above and parallel to each buried pipe.

3.3 VALVE IDENTIFICATION

A. Provide CMMS Tags for valves as specified under Section 01 93 13.15, Computerized Maintenance Management System Tags, and as shown on the drawings.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
1. Locations of existing piping shown on the Drawings should be considered approximate.
2. Determine the true locations of existing piping to which connections are to be made, and locations of other facilities which could be disturbed during earthwork operations, or which may be affected by CONTRACTOR'S Work already installed.
3. Conform to applicable requirements of Division 1, General Requirements, pertaining to cutting and patching and connections to existing facilities.

B. Taking Existing Pipelines Out of Service:
1. Do not take pipelines out of service, unless specifically listed below, or approved by ENGINEER.
a. Refer to Section 01 14 16, Coordination With OWNER'S Operations.

2. Notify ENGINEER at least 48 hours prior to taking pipeline out of service.

C. Work on Existing Pipelines:
1. Cut or tap pipes as shown on the Drawings or required, with machines specifically designed for this Work.
2. Install temporary plugs to prevent entry of mud, dirt, water and debris.
3. Provide all necessary adapters, fittings, pipe and appurtenances required to complete the Work.
4. Existing pipelines which are cut and abandoned shall be adequately capped or filled with grout.

3.5 TESTING

A. General:
1. Upon completion of piping, but prior to application of insulation on exposed piping, test the piping systems. Pressures, media and test durations shall be as specified in Article 3.7, below. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, notify the ENGINEER 24 hours prior to each test.
2. Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new piping systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.
3. Where testing existing chlorine and sulfur dioxide systems to the nearest isolation valve, provide a tee in the line adjacent to the valve. The branch outlet on the tee shall be valved and used for cleaning, pressure testing, draining, and drying the line. Unless otherwise indicated, the existing chlorine or sulfur dioxide system shall not be shut down during testing or connecting the tee and valve. Prior to placing the line in service, the valve on the branch outlet shall be plugged or sealed with a blind flange or threaded plug. Responsibility belongs to CONTRACTOR for all damage to the existing system as a result of this work.

B. Gas, Air, and Vapor Systems:
1. Test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.
2. Testing medium and procedures for chlorine systems are specified in Paragraph 3.5.D., below.
3. Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

Pipeline size	Specified Test Pressure	Testing medium
2-inch and smaller	75 psi or less	Air or water
2-inch and smaller	Greater than 75 psi	Water
Greater than 2-inch	3 psi or less	Air or water
Greater than 2-inch	Greater than 3 psi	Water

4. Potable Water Systems Additional Requirements:
    a. The CONTRACTOR shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, including measuring device and all other equipment necessary for making the tests, except pressure gages.
    b. The pipe shall be tested between each valve or between a valve and the closed end of the pipe.
    c. Pipe test section shall be limited to 1/2 linear mile, or less, unless otherwise approved in writing by the Engineer. Testing cannot be done against an existing valve. The new pipeline must be separated from any potable system in such a way to prevent any potential for cross-contamination between the existing potable water system and the new pipeline.
    d. The test shall be made after the backfilling is completed or compacted, regardless of the compaction method.
    e. All connections, blow-offs, hydrants and valves shall be tested with the main, where practical.
    f. The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as approved by the Superintendent of Water Distribution, with at least 24-hour notice required before filling is scheduled.

C. Liquid Systems:
1. Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: Exposed piping, buried piping, and buried or exposed piping carrying liquid chemicals. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

D. Chlorine Systems:
1. General: Chlorine systems comprise of chlorine, in gaseous and liquid phase, under positive and negative pressure. After cleaning, as specified in Paragraph 3.6.E., below, the system shall be pressure tested. Pressure gages, relief valves, automatic control valves, and other components which may be damaged or exceeded by test pressures shall be removed and openings shall be blocked off prior to testing. Do not attempt to repair leaks until all pressure has dissipated from the system. The system shall be repaired and retested, as necessary, until a successful test (zero leakage) is achieved.
    a. For evaporator-supplied systems, disconnect the vent from the discharge side of the pressure relief valve of each evaporator, plug the resultant opening, inspect and secure all joints, close all valves which discharge to atmosphere, and open all in-line valves. Open the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator to provide a through path around this valve. System piping shall then be tested to 150 psig. After testing, replace all equipment previously removed and close all in-line valves. Reconnect the vent line to the downstream side of the pressure relief valve of each evaporator and close the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator.

b. Steel pipelines shall be hydrostatically tested. However, if drying after hydrostatic testing is impractical or cannot be accomplished, test steel lines with nitrogen gas or dry air providing, that all the necessary safety precautions to safeguard personnel and minimize the risk incurred when performing such a test at high pressures have been taken. All CPVC pipelines shall be hydrostatically tested. Testing CPVC lines with nitrogen or air is not permitted.

2. Hydrostatic Testing: Steel piping lines and CPVC solution lines hydrostatically tested shall be tested to 150 psig. CPVC vacuum lines shall be hydrostatically tested to 50 psig. After testing, all moisture absorbing gaskets and valve packing shall be replaced.
3. Drying: Chlorine piping systems shall be dried prior to placing in service. Even if water has not been purposely introduced into the system for hydrostatic testing or cleaning, drying is still required because moisture may enter the system from the atmosphere or other sources.
   a. For steel pipe, drying shall be accomplished by passing steam through the lines from the high end of the system until the lines are thoroughly heated. While steaming, allow condensate and foreign matter to drain out. The steam supply shall then be disconnected and all pockets and low spots in the line drained. While the line is still warm, dry oil-free air having a dew point of -40°F, or below, shall be blown through the line until the exiting air dew point is the same as the supply air. Valves shall be fixed in the half-open position during drying. Valves removed temporarily from the system during drying operations must be free of moisture before being recoupled to the piping system.
   b. Drying of CPVC pipe applies solely to vacuum lines and consists of draining and removing all water and moisture from the system. After draining the line, first "pig" the pipe to remove excess water. Then air dry the system in accordance with the requirements for steel pipe. CPVC pipe shall not be steamed.
4. Nitrogen or Air Pressure Testing: May use nitrogen gas or oil-free dry air to test steel lines. Testing consists of gradually introducing nitrogen gas or dry air up to 50 psig and maintaining this pressure while testing the line for leaks with soapy water. When the system is free from leaks at this pressure, the test pressure shall then be increased in increments of 50 psig up to a maximum of 150 psig. At each stepped increase in pressure, check for leaks and take corrective action as necessary. When the system is free from leaks at the final test pressure, the system shall then be depressurized, the test source disconnected, and the system capped to prevent the entrance of water.
   a. For testing with nitrogen gas, use cylinders of dry high purity nitrogen gas, nitrogen handling cylinder mounted pressure regulator 0 to 300 psig, and necessary fittings and adapters to complete connection between the source and system header. Pressure regulator shall be self-relieving type, which vents to the atmosphere, and includes a throttling valve.
   b. For testing with air, provide oil-free air with a relative humidity of zero. All fittings, adapters, and accessories, pressure regulator and throttling valve shall be suitable for pressure testing with air and rated for 300 psig service.
5. Service Gas Testing: Immediately after the chlorine system has been dried and pressure tested, the service gas shall be gradually introduced and the

entire system tested for leaks. Time shall be allowed for the complete replacement of air from the piping with service gas.

a. Use a liquid ammonia solution or chlorine gas detector to detect for chlorine leaks. Spray the solution at the pipe connections and shall not squirt the liquid on the pipe or fittings. In the event leaks are detected in the piping or the equipment, they shall not be repaired until all gas has been purged from the line. The reaction of the two substances produces a dense white cloud. Upon completion of repairs, repeat the cleaning and drying process described in this Paragraph and in Paragraph 3.6.E., below, and retest the lines with service gas.

E. Hydraulic and Lube Oil Systems:

1. Upon completion of cleaning, all field connections shall be completed and the system tested at the specified pressure. Pressure loss shall be zero for the specified test period. For fluid power systems, the manufacturer shall supervise the installation and testing of all system components including all field piping.

F. Drains:

1. Drain systems, other than pumped drain systems, shall be tested in accordance with Phoenix Plumbing Code.

G. Diesel Fuel:

1. Upon completion of cleaning, all field connections shall be completed and the system tested at the specified pressure. Pressure loss shall be zero for the specified test period.

3.6 CLEANING AND FLUSHING

A. General:

1. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, and regulating or instrumentation equipment. At CONTRACTOR'S option, may clean and test sections of the buried or exposed piping systems. Use of this procedure; however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24-inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24-inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Temporary Screens:

1. Upon completion of the cleaning, connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment Suction Or Piping Size, (Inches)	Maximum Screen Opening, (Inches)
0 to 1	1/16

Equipment Suction Or Piping Size, (Inches)	Maximum Screen Opening, (Inches)
1-1/4 to 3	1/4
3-1/2 to 6	1/2
Over 6	1

2. Maintain the screens during testing, initial start-up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. Remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Systems handling solids are exempted.

C. Gas and Air Systems:
   1. Unless otherwise specified, gas and air system piping 6-inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than 6-inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an airstream. Propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until put in service. Sludge gas systems shall be purged with nitrogen and a nitrogen pad maintained at 3 psi until put in service.

D. Liquid Systems:
   1. After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens.

E. Chlorine Systems:
   1. General: All portions of the system shall be cleaned free of oil and grease.
   2. Steel Pipe: All pipe threads shall be washed clean and free from cutting oil. The inside of all pipe sections and fittings shall be cleaned of any pipe dope, oil and grease by drawing a cloth wetted with solvent through each assembly. Valves shall be dismantled, thoroughly cleaned with solvents, and repacked, if necessary. Cap or plug all open ends at the end of each day's Work.
      a. Use carbon tetrachloride or trichloroethylene. At all times exercise caution to minimize solvent exposure and shall be responsible for its proper handling and disposal. Solvents containing hydrocarbons or alcohols are unacceptable.
   3. CPVC Pipe: All solution lines shall be cleaned using water only. Vacuum lines shall be cleaned with a detergent and water and thoroughly rinsed to remove all vestiges of detergent. All lines shall be further purged of water by passing a cleaning ball or swab through the lines as specified in Paragraph 3.6.A., above.

F. Steam Systems:
   1. Before the steam system is put into service, cleaning shall be performed to remove such contaminants as mill scale, weld scale, corrosion products, oil, grease, dust and dirt. Cleaning shall include a water flush performed at a

velocity not less than two feet per second, steam blowdown, and an alkaline flush boilout of the boiler.

2. After flushing as indicated above, the boiler shall be treated with a caustic compound such as sodium triphosphate, soda ash, sodium tripolyphosphate, or caustic soda. The cleaning process shall be in accordance with steam system cleaning schemes developed by Dowell, the Mogul Division of Dexter Corp., Bentz Entec, or equal.
3. After cleaning and flushing, and prior to continuous operation of the steam system, adequate corrosion protection shall be provided by maintaining the system full of steam or potable water. If continuous operation does not occur within 60 days after cleaning and flushing, the steam or potable water shall be treated with an acceptable corrosion inhibiting chemical to ensure adequate corrosion protection of the steam system.

G. Hydraulic and Fluid Power Oil Systems:
1. Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D 4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as required in Paragraph 1.3.B., above, that the ACL has been met.

H. Potable Water Systems:
1. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

3.7 PIPING SPECIFICATION SHEET

A. General:
1. Piping and valves for groupings of similar plant processes or types of service lines are specified on individual Piping Specification Sheets. Piping systems are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of systems is identified by a piping system number. Piping systems specified on the Drawings are numerically arranged by system as shown in Table A. Table A also indicates the system number and fluid category for each service.
   a. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted four feet above the floor. Vents in piping systems for fluids containing solids shall be 1-inch nonlubricated eccentric plug valves fitted with quick couplers.
   b. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted four feet above the floor. Drain valves shall be threaded end gate valves of the size specified or as shown on the Drawings. When drains cannot be run to collection points, they shall be

routed to a point of easy access and shall have hose gate valves of the size specified.

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Table A - Piping Systems

Article No.	System No.	Symbol	Service Descriptions	Fluid Category
3.8	2	HPA	High Pressure Air	Air
3.9	7	CW	Domestic Cold Water	Water
	7	PW	Potable Water	Water
3.10	21A	FEC	Ferrous Chloride	Chemical
3.11	24	SW	Sanitary Waste	Drain/Vent
	24	STDR	Storm Drain	Drain/Vent
	24	V	Vent	Drain/Vent
	24	RD	Roof Drain	Drain/Vent
	24	NSD	Non-Sanitary Drain	Drain/Vent
3.12	32	OCD	Odor Control Drain	Drain/Vent
	32	SBD	Scrubber Blowdown	Drain/Vent

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3.8 SYSTEM - 2

Piping Symbol/Service: HPA High Pressure Air

Test Requirements:	Medium:	Refer to paragraph 3.5.B., above.
	Pressure:	300 psig for exposed, 200 psig for buried.
	Duration:	120 minutes.
Gasket Requirements:	Flange:	N/A.
	Push-on/Mech Cpl:	N/A.

Exposed Pipe/Valves:

2-inches and smaller	Pipe:	Copper Tube:	Type K (rigid). Refer to Section 33 05 17, Copper Pipe. (Refer to Remark 2)
		Conn:	Screwed. (Refer to Remark 2)
		Ftgs:	Refer to compressed air manufacturer recommendations.
2-inches and smaller	Valves:	Refer to compressed air manufacturer recommendations.	

Buried and Encased Pipe/Valves:

2-inches and smaller	Pipe:	Copper Tube:	Type K with polyethylene tape coating. Field application of coating to all couplings, Refer to Section 33 05 17, Copper Pipe.
		Conn:	Solder type, threaded adapters for valves.
		Ftgs:	Refer to compressed air manufacturer recommendations
2-inches and smaller	Valves:	Same as exposed with extension stem and valve box.	

Remarks:
1. Refer to Drawings for pipe size and valve type.

3.9 SYSTEM – 7

Piping Symbol/Service: CW Domestic Cold Water
PW Potable Water

Test Requirements:	Medium:	Water: Refer to Paragraph 3.5.C., above.
	Pressure:	Refer to Section 22 00 12, Testing of Plumbing Piping Systems: 200 psig for exposed ductile iron pipe, otherwise 125 psig.
	Duration:	60 minutes.

Piping Symbol/Service:	CW PW	Domestic Cold Water Potable Water

Gasket Requirements:	Flange:	Refer to Section 33 05 19, Ductile Iron Pipe. Refer to Section 33 05 31, Thermoplastic Pipe.	
	Push-on/Mech Cpl:	Refer to Section 33 05 19, Ductile Iron Pipe.	
Exposed Pipe/Valves:			
3-inches and smaller	Pipe:	Copper Tube:	Type K (rigid). Refer to Section 33 05 17, Copper Pipe and Section 22 11 16, Potable Water Piping System.
		Conn:	Solder type with threaded or flanged adapters for valves.
		Ftgs:	Refer to Section 33 05 17, Copper Pipe.
2-inches and smaller	Valves:	Refer to Section 22 11 16, Potable Water Piping System.	
4-inches and larger	Pipe:	Ductile Iron:	Class 53 with cement mortar lining. Refer to Section 33 05 19, Ductile Iron Pipe.
		Conn:	Grooved mechanical pipe coupling or flanged.
		Ftgs:	Refer to Section 33 05 19, Ductile Iron Pipe, ends and lining to match pipe.

3.9 SYSTEM – 7 (Continued)

Piping Symbol/Service:	CW	Domestic Cold Water
	PW	Potable Water

Buried and Encased Pipe/Valves:

3-inches and smaller	Pipe:	Copper Tube:	Type K with polythelene tape coating. Field application of coating to all couplings. Refer to Section 33 05 17, Copper Pipe.
		Conn:	Solder type, with threaded or flanged adapters for valves.
		Ftgs:	Refer to Section 33 05 17, Copper Pipe.
3-inches and smaller	Valves:	Gate:	Refer to Section 40 05 61, Gate Valves, Operators and Appurtenances, with extension stem and valve box. Coating in accordance with Section 09 90 00, Painting and Coating.

3.10 SYSTEM – 21A

Piping Symbol/Service: FEC Ferrous Chloride

Test Requirements:	Medium:	Water: Refer to Paragraph 3.5.C., above.	
	Pressure:	200 for CPVC,	
	Duration:	120 minutes.	
Gasket Requirements:	Flange:	Refer to Section 33 05 31, Thermoplastic Pipe.	
	Push-on/Mech Cpl:	N/A.	
Exposed Pipe/Valves:			
4-inches and smaller	Pipe:	CPVC:	Sch. 80. Piping and fittings exposed shall be painted. Refer to Section 33 05 31, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld, flanged for valves 3-inch and larger.
		Ftgs:	Refer to Section 33 05 31, Thermoplastic Pipe.
4-inches and smaller	Valves:	Refer to Section 40 05 66, Thermoplastic Valves, Operators and Appurtenances.	
Buried and Encased Pipe/Valves:			
4-inches and smaller	Valves:	Same as exposed with extension stem and valve box.	

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

3.11 SYSTEM - 24

Piping Symbol/Service:

SW	Sanitary Waste
STDR	Storm Drain
V	Vent
RD	Roof Drain
NSD	Non-Sanitary Drain
STDR	Storm Drain

Test Requirements:	Medium:	In accordance with Phoenix Plumbing Code.
	Pressure:	In accordance with Phoenix Plumbing Code.
	Duration:	In accordance with Phoenix Plumbing Code.
Gasket Requirements:	Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
	Push-on/Mech Cpl:	Nitrile or neoprene.

Piping Symbol/Service:	SW	Sanitary Waste
	STDR	Storm Drain
	V	Vent
	RD	Roof Drain
	NSD	Non-Sanitary Drain
	STDR	Storm Drain

Exposed Pipe/Valves:

2-inches thru 12-inches	Pipe:	PVC:	Refer to Section 33 05 31, Thermoplastic Pipe
		Conn:	Refer to Section 33 05 31, Thermoplastic Pipe
		Ftgs:	Refer to Section 33 05 31, Thermoplastic Pipe .
2-inches thru 12-inches	Pipe:	Ductile Iron:	AWWA C151. Refer to Section 33 05 19, Ductile Iron Pipe.
		Conn:	Flanged or mechanical.
14-inches and larger	Pipe:	Ductile Iron:	AWWA C151. Refer to Section 33 05 19, Ductile Iron Pipe.
		Conn:	Flanged or mechanical.

SYSTEM – 24 (Continued)

Piping Symbol/Service:	SW	Sanitary Waste
	STDR	Storm Drain
	V	Vent
	RD	Roof Drain
	NSD	Non-Sanitary Drain

14-inches and larger (Cont'd)	Pipe:	Ftgs:	Refer to Section 33 05 19, Ductile Iron Pipe. Ends to match pipe.

Buried and Encased Pipe/Valves:

12-inches and smaller	Pipe:	Ductile Iron:	Same as exposed.
12-inches and smaller	Valves:	N/A.	
14-inches and larger	Pipe:	Ductile Iron:	Same as exposed.
14-inches and larger	Valves:	N/A.	

Buried and Encased Pipe and Valves Beyond 5 Feet Outside Building:

8-inches and smaller	Pipe:	CPVC:	ASTM D 1784, Class 23447-B, ASTM F 441, Sch. 80. Refer to Section 33 05 31, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld.
		Ftgs:	CPVC, socket type, DWV, ASTM F 493.
8-inches and smaller	Valves:	N/A.	
10-inches and 12-inches	Pipe:	CPVC:	ASTM D 3034, SDR 35.
		Conn:	Push-on with nitrile gasket.
		Ftgs:	CPVC or IPS cast iron: Ends to match pipe.
10-inches and 12-inches	Valves:	N/A.	

SYSTEM – 24 (Continued)

Piping Symbol/Service:	SW	Sanitary Waste
	STDR	Storm Drain
	V	Vent
	RD	Roof Drain
	NSD	Non-Sanitary Drain

14-inches and larger	Pipe:	VCP:	Refer to MAG 743
		Conn:	Refer to MAG 743
		Ftgs:	Concrete manhole as shown on the Drawings.
14-inches and larger	Valves:	N/A.	

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

3.12 SYSTEM - 32

Piping Symbol/Service: OCD Odor Control Drain

Test Requirements:	Medium:	Water: Refer to Paragraph 3.5.C., above.
	Pressure:	OCD test at 25 psig, SBD test at 100 psig.
	Duration:	120 minutes.
Gasket Requirements:	Flange:	N/A.
	Push-on/Mech Cpl:	N/A.

Exposed Pipe/Valves:

All sizes	Pipe:	CPVC:	Sch. 80. Refer to Section 33 05 31, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld.
		Ftgs:	Refer to Section 33 05 31, Thermoplastic Pipe.
All sizes	Valves:	Refer to Section 40 05 66, Thermoplastic Valves, Operators and Appurtenances.	

Buried and Encased Pipe/Valves:

All sizes	Pipe:	CPVC:	Sch. 80. Refer to Section 33 05 31, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld same as exposed.

Piping Symbol/Service: OCD Odor Control Drain

		Ftgs:	Refer to Section 33 05 31, Thermoplastic Pipe.
All sizes	Valves:	N/A.	

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

SECTION 33 71 19.13

ELECTRICAL MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install manholes and handholes.

B. Coordination: Coordinate manhole and handhole installation with piping, sheeting and other underground systems and structures and locate clear of interferences.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) current adoption.
   2. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for manholes, handholes and accessories proposed for use.
   2. Drawings showing interior and exterior dimensions and details of openings, jointing, inserts and reinforcing.
   3. Elevations of each wall of each manhole and hand hole showing conduit window dimensions and conduit diameters and conduit numbers of all conduits entering each wall with each conduit number indicated to show that window is of sufficient size.
   4. Calculations, listed by manhole and handhole name, showing that submitted manhole and handhole sizes for each manhole and each hand hole are sized in accordance with National Electrical Code, Article 314.28.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material and Construction:
   1. Precast or cast-in-place type of reinforced concrete.
   2. Minimum interior dimensions as shown on the Drawings.
   3. Duct entrances sized and located to suit duct banks.
   4. Handholes and Manholes must have a bottom.

B. Accessories:
   1. Frames and Covers:
      a. Material: Cast iron conforming to ASTM A 48, Class 30A.
      b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised 2-inch letters. Identify covers as shown on the Drawings. Manhole covers to be 36-inch minimum.
      c. Frame shall be grouted on the manhole or handhole.
      d. Product and Manufacturer: Provide frames and covers of one of the following:
         1) Neenah Foundry Company.
         2) Campbell Foundry Company.
         3) Or equal.
   2. Frames and Covers:
      a. Material: Covers and frames shall be cast aluminum alloy, Class H-20 highway rated.
      b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised 2-inch letters. Identify covers as shown on the Drawings.
         1) Manhole covers to be 36 inch minimum.
      c. Frame shall be grouted on the manhole or handhole.
      d. Product and Manufacturer: Provide frames and covers of one of the following:
         1) Neenah Foundry Company.
         2) Campbell Foundry Company.
         3) Or equal.
   3. Pulling Irons:
      a. Material: Galvanized steel.
      b. Cast in the wall opposite to the centerline of each incoming duct bank and 12-inches below centerline of bottom line of ducts.
      c. Product and Manufacturer: Provide one of the following:
         1) Catalog No. 8119 by A.B. Chance Company.
         2) Catalog No. DU2T3 by McGraw Edison Company.
         3) Or equal.
   4. Cable Racks:
      a. Material: Galvanized steel.
      b. Cable racks shall adequately support cables with space allowed for future cables.
      c. Each rack shall be a vertical assembly of 24-inch cable racks extending from within 6-inches of the manhole roof slab to within 6-inches of the manhole floor.
      d. Product and Manufacturer: Provide one of the following:
         1) Catalog No. J-5125 by Joslyn Manufacturing Company.
         2) Catalog No. C203-1125 by A.B. Chance Company.
         3) Or equal.
   5. Cable Hooks:
      a. Material: Galvanized steel.
      b. Length: 7-1/2-inch minimum.
      c. Product and Manufacturer: Provide one of the following:
         1) Catalog No. J-5132A by Joslyn Manufacturing Company.
         2) Catalog No. C203-1132 by A.B. Chance Company.
         3) Or equal.

6. Insulators:
   a. Material: Porcelain.
   b. Product and Manufacturer: Provide one of the following:
      1) Catalog No. J-5122 by Joslyn Manufacturing Company.
      2) Catalog No. C203-1120 by A.B. Chance Company.
      3) Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install manholes and handholes where shown on the Drawings. Verify final locations in field. Responsibility belongs to CONTRACTOR for all excavation and backfilling required for installation.

B. Complete installation of manholes and handholes so that structures are watertight. Apply foam sealant to all openings and penetrations. Seal all conduit openings to provide a water/bug-tight seal.
   1. Product and Manufacturer: Provide one of the following:
      a. Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney
      b. Type FST Foam Sealant, as manufactured by American Polywater Corp
      c. Or equal.

C. Cable Supports in Manholes:
   1. Attach cable racks with 3-inch by 3/8-inch diameter "tamp-in" studs mounted in 1-inch holes drilled into walls of manholes in the absence of inserts. Apply PVC coating to all racks.
   2. Provide cable hooks to support each cable on each rack along the cable run within the manholes. Apply PVC coating to all hooks.
   3. Individually support each cable at each hook on porcelain insulators. Provide sufficient slack for each cable.
   4. Securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape as manufactured by 3M or tie down with nylon straps.

D. Grounding: Install a 3/4-inch by 10-foot copper-clad ground rod for each manhole. Bond all exposed metal manhole accessories and the concrete reinforcing rods with No. 4 AWG minimum bare copper wire and connect to the ground rod and to the duct bank ground cable.

E. Sump: Provide a 12-inch by 12-inch by 6-inch sump in manhole floor.

F. Provide grading rings for manholes when required to adjust cover to proper grade. Grading ring shall be minimum of 12-inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the grading ring shall be such as is necessary to bring the frame to the proper grade.

G. Metal Pullbox: Install NEMA 4X stainless steel wall mounted pullbox inside manholes/handholes where analog signal cables are mixed with power cables. Route conduits for analog cables directly into and out of metal pullbox so that no analog cables are exposed.

+ + END OF SECTION + +

SECTION 33 71 19.24

UNDERGROUND DUCT BANKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install underground duct banks.

B. Coordination: Duct bank routing on the Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences.

C. Standard conduit chairs shall be used for all conduit raceway supports.

D. Definition: A duct bank is one or more buried electrical conduits.

E. Definition: A duct bank is one or more buried electrical conduits between buildings, slabs, etc. not to include under slab raceways that serve the structure/equipment on the slab.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Layouts showing the proposed routing of duct banks and the locations of manholes, handholes and areas of reinforcement.
   2. Profiles of duct banks showing crossings with piping and other underground systems.
   3. Typical cross sections.
   4. Installation procedures.

B. Record Drawings: Include the actual routing of underground duct runs on Record Drawings in accordance with Section 01 78 39, Project Record Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Duct: Schedule 40 PVC conduit and fittings in accordance with Section 26 05 33.13 - Conduit for Electrical Systems.

B. Exposed: PVC Coated Galvanized Rigid Metal Conduit: PVC coated rigid metal conduit and fittings in accordance with Section 26 05 33.13, Conduit for Electrical Systems, if required.

C. Backfill: Select backfill in accordance with Section 31 23 00, Structural Excavation and Backfill.

D. Reinforcement: In accordance with Section 03 20 00, Concrete Reinforcing.

E. Concrete: In accordance with Section 03 30 00, Cast-In-Place Concrete (Large Projects).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Duct banks shall be installed as follows:
   1. For small direct burial duct banks (3 conduits or less) use of PVC coated rigid metal conduit. Concrete and reinforcement are not required. Warning tape is required.
   2. For larger duct banks, use PVC conduit, to be encasement, reinforcement and warning tape. All bends (vertical and horizontal) of 45º or more require PVC coated rigid metal conduit.

B. Excavation and backfilling required for duct bank installation.

C. All duct bank installations and penetrations through foundation walls shall be watertight and in accordance with Section 26 05 33.13 - Conduit for Electrical Systems.

D. Top of duct banks shall be a minimum of 24-inches below grade, unless otherwise approved by the ENGINEER.

E. Assemble duct banks using non-magnetic saddles, spacers and separators. Position the separators to provide 3-inch minimum concrete separation between the outer surfaces of the ducts. Side forms are only required to prevent excessive widening of the duct bank where over excavation has occurred.

F. Provide a 3-inch minimum concrete covering on sides, top and bottom of concrete envelopes around conduits. Concrete covering size shall be as shown on the Drawings. Add red oxide to concrete for easy identification during subsequent excavation. The red oxide is to be added in the concrete truck prior to the concrete being placed. Red oxide concrete shall include the entire duct bank, top and bottom unless under a slab.

G. Firmly fix ducts in place during placing of concrete. Carefully place and vibrate the concrete to ensure filling of all spaces between ducts.

H. Conduits entering floor mounted equipment, such as, switchgear compartments, motor control centers, transformers shall terminate with PVC coated rigid metal conduit factory 90º elbows, RNC risers and bell ends.

I. Reinforce all duct banks.
   1. Unless otherwise shown on the Drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 18-inches on centers, and No. 3 tie-bars transversely placed at 18-inch maximum longitudinal intervals. Overlap of No. 3 tie-bars shall be a minimum of 4-inches.
   2. Maintain a maximum clearance of 1-inch from bars to the edge of the concrete encasement.
   3. Install dowel reinforcement rebar where duct bank meets other concrete structures.

J. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.

K. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.

L. Install a bare stranded copper duct bank ground cable (4/0 or as shown on drawings) in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground cable to building and station ground grid or to equipment ground buses. In addition, connect ground cable to steel conduit extensions of the underground duct system. Provide ground clamp and bonding of each steel conduit extension, where necessary to maintain continuity of the ground system. Terminate ground cable at last manhole or handhole for outlying structures.

M. After completion of the duct bank or utilizing existing ducts and prior to pulling cable, pull a mandrel, not less than 12-inches long and with a cross section approximately 1/4-inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.

N. Pulling Rope/Tape
   1. Pulling rope or tape shall be constructed of polyester and factory lubricated. Nylon is not allowed.

O. Warning Ribbon:
   1. Provide as stated in Specification Section 26 05 33.13.

P. Plug and seal empty spare ducts entering buildings and structures. Install pulling tape in all empty spare ducts. Seal watertight all ducts in use entering buildings and structures in accordance with Section 26 05 33.13 - Conduit for Electrical Systems.

+ + END OF SECTION + +

SECTION 33 73 23

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide the labor, materials, equipment, incidentals required to furnish and install dry type transformers 150 KVA and larger with copper windings, complete and operational, as specified and shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. ANSI C89.1, Specialty Transformers.
   2. ANSI C89.2, Dry-Type Transformers for General Applications.
   3. UL Standard No. 506, Specialty Transformers.
   4. UL Standard No. 1561, including UL K factor listed.
   5. NEMA ST-20 and ASNI C89.2, Sound Levels.
   6. National Electrical Code (NEC) current adoption.
   7. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for transformers proposed for use, including pad layout, materials, dimensions, etc.
   2. Listing of the transformers to be furnished with their ratings and proposed locations identified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Type: Low-temperature rise, dry type, general purpose.
   2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
   3. Windings: Copper
   4. Taps: Full capacity, two 2-1/2 percent primary taps above normal and a minimum of two 2-1/2 percent primary taps below normal.
   5. Enclosure: UL listed for either indoor or outdoor use.
   6. Insulation: Class 220°C, 115°C rise.

7. Identification: Identify transformers in accordance with Section 26 05 01, General Provisions, identifying the transformer identification number, primary and secondary power identification and voltages.

B. Non Linear Load, K Factor Rated Transformer (When Required):
   1. Type: 100 percent non-linear rated, specifically designed to handle non-linear loads with double size neutral. Transformer shall include an electrostatic shield grounded to the transformer core.
   2. UL K Factor: K=13.
   3. Impedance: Three percent minimum, five percent maximum.

C. Product and Manufacturer: Provide one of the following:
   1. General Electric Company.
   2. Jefferson.
   3. Square D Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install transformers on walls or floors at locations shown on the Drawings. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for ready and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the structural parts of the building or to other equipment. Make connections to transformers with flexible conduit.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Ground transformer properly and install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

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SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install and test all exposed piping, fittings, and specials. The Work includes, but is not limited to, the following:
      a. All types and sizes of exposed piping, except those specified under other Sections.
      b. Piping embedded in concrete within a structure or foundation will be considered as exposed and included herein.
      c. Supports, restraints, thrust blocks and other anchors.
      d. Work on or affecting existing piping.
      e. Testing.
      f. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the exposed piping installation.
      g. Incorporation of valves, meters and special items shown on the Drawings or specified into the piping systems as required and as specified in the appropriate Division 15, Mechanical, Sections.
      h. Unless otherwise specifically shown on the Drawings, specified, or included under other Sections, all exposed piping Work required, beginning at the outside face of structures or structure foundation and extending into the structure.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.
   2. Section 40 05 05, Exposed Piping Installation, specifies the installation of all exposed piping materials specified in Division 15, Mechanical. Coordinate with these Sections.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Comply with applicable requirements of NFPA Standard No. 13 for "Installation of Sprinkler Systems" and NFPA Standard No. 14 for "Standpipe and Hose Systems" used for fire protection.
   2. Comply with requirements of UL, FM and other jurisdictional authorities, where applicable.
   3. Refer to the General and Supplementary Conditions regarding requirements for this Project.
   4. Phoenix Building Code.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B 16.3, Malleable-Iron Threaded Fittings, Classes 150 and 300.
   2. ANSI B 16.4, Cast Iron Threaded Fittings, Classes 125 and 250.
   3. ANSI B 16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
   4. ANSI B 16.9, Factory-Made Wrought Steal Butt Welding Fittings.
   5. ANSI B 16.11, Forged Steel Fittings, Socket-Welding and Threaded.
   6. ANSI B 31.1, Power Piping.
   7. ANSI B 31.3, Chemical Plant and Petroleum Refinery Piping.
   8. ANSI B 31.8, Gas Transmission and Distribution Piping Systems.
   9. AWWA C 111, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   10. AWWA C 206, Field Welding of Steel Water Pipe Joints.
   11. AWWA C 600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   12. AWWA C 606, Grooved and Shouldered Type Joints.
   13. AWWA M9, Concrete Pressure Pipe.
   14. AWWA M11, Steel Water Pipe Design and Installation.
   15. AWWA M23, PVC Piping.
   16. AWS D 1.1, Structural Welding Code.
   17. AWS D 10.7, Recommended Practices For Gas Shielded-Arc Welding of Aluminum and Aluminum Alloy Pipe.
   18. AWS D 10.9, Standard for Qualification of Welding Procedures and Welders for Piping and Tubing.
   19. ASME Boiler and Pressure Vessel Code.
   20. NFPA 13, Installation of Sprinkler Systems.
   21. NFPA 14, Standpipe and Hose Systems.
   22. NFPA 54, National Fuel Gas Code.
   23. Phoenix Building Code.
   24. NSF/ANSI 61, Drinking Water System Components Health Effects
   25. Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings in plan and section, and laying schedules.
   2. Details of piping, valves, supports, accessories, specials, joints, harnessing, and connections to existing pipes and structures.

B. Tests: Submit description of proposed testing methods, procedures and apparatus. Submit copies of test report for each test.

C. Certificates: Submit certificates of compliance with referenced standards.
   1. Welder's Certificate to comply with the requirements of Paragraph 3.1.D.5.b.1) of this Section, below.

2. Certificate of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-4-119, in accordance with section 11 00 00 requirements.

D. Record Drawings:
1. Submit Record Drawings prior to the time of Substantial Completion and per the requirements of 01782 Record Documents.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks. Do not otherwise drop, roll or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings and specials opposite to or as close to the location where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or other damaged material and immediately remove from site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Required pipe materials are listed in Section 33 14 10, Piping Systems. Refer to applicable Sections for material specifications.

B. General:
1. Marking Piping:
a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
b. Cast or paint material, type and pressure designation on each piece of pipe or fitting 4-inches in diameter and larger.
c. Pipe and fittings smaller than 4-inches in diameter shall be clearly marked by manufacturer as to material, type and rating.

C. Responsibility to coordinate compatible materials of construction for all elastomer components for all seats, seals, gaskets, etc., for each process application belongs to COONTRACTOR. Acceptable compatible materials of construction for all elastomer materials are as follows:

Process Fluid	Compatible Materials of Construction
Ferric Chloride	Buna, EPDM, Teflon, Viton
Hydrochloric Acid	Teflon, Viton
Sodium Hydroxide	Teflon, Hypalon, Polypropylene
Sodium Hypochlorite	Teflon, PVDF, Hypalon, Polypropylene
Polymer	Viton, Teflon
Methanol	Buna-N, Teflon

D. Pipe Identification Markers and Arrows: Refer to Section 09 90 00, Painting and Coating.

E. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under the section, shall require NSF/ANSI 61, drinking water system components health effects, approval or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install piping as shown on the Drawings, specified and as recommended by the manufacturer.
2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request instructions from ENGINEER before proceeding.

B. Piping Installation:
1. Install straight runs true to line and elevation.
2. Install vertical pipe truly plumb in all directions.
3. Install piping parallel or perpendicular to building walls. Piping at angles and 45 degree runs across corners will not be accepted, unless specifically shown on the Drawings or approved by the ENGINEER.
4. Install small diameter piping generally as shown on the Drawings when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
5. Install piping so as to leave all corridors, walkways, work areas, and like spaces unobstructed. Unless otherwise approved by the ENGINEER, provide a minimum headroom clearance under all piping of 7 feet-6 inches.
6. Protect and keep clean water pipe interiors, fittings and valves.
7. Provide temporary caps or plugs over all pipe openings at the end of each day's work, and when otherwise required or directed by ENGINEER.
8. Cutting: Cut pipe from measurements taken at site, not from Drawings.
9. Install dielectric unions or dielectric flange kits with sleeves and washers wherever dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
10. Provide a union downstream of each valve with screwed connections.

11. Provide screwed or flanged unions at each piece of equipment, where shown on the Drawings, and where necessary to install or dismantle piping.
12. Additional Requirements for Thermoplastic Piping:
    a. Support all valves independently of the piping system.
    b. Utilize wide band supports as recommended by manufacturer and approved by ENGINEER to minimize localized stresses.
    c. Provide piping passing through walls with a sleeve of wearing material to prevent abrasion damage to piping.
    d. When anchors are required at locations other than equipment or tanks they shall be placed at elbows, valve locations and at bends in pipe line.
    e. Spacing of supports shall be in accordance with the manufacturer's published recommendations at the maximum design operating temperature of the pipe and requirements of Section 22 05 29, Pipe Hangers and Supports.
    f. Use "U" clamps with wide band circumferential contact.
    g. Use guides on long runs of piping to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by manufacturer.
    h. Expansion compensation shall comply with the requirements of Section 15061, Pipe Hangers and Supports.
    i. Provide air chambers with shut-off and drain valve on all pump discharge lines to reduce hydraulic hammer and flexible connectors to absorb vibration. Submit details for ENGINEER to review.
    j. Do not install pipe when temperature is less than 60°F.

C. Joints:
    1. General:
        a. Make joints in accordance with the pipe manufacturer's instructions and recommendations and the requirements below.
        b. Cut piping accurately and squarely and install without forcing or springing.
        c. Ream out all pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
        d. Remove all cuttings and foreign matter from the inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
    2. Mechanical Joint Pipe:
        a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
        b. Lubricate the plain end and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with AWWA C 111, just prior to slipping the gasket onto the plain end of the joint assembly.
        c. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
        d. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
        e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
        f. Insert bolts and hand tighten nuts.

g. Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1-1/4	120 to 150

3. Flanged Joints:
   a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by ENGINEER. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Bolts shall be tightened in a sequence which will ensure equal distribution of bolt loads.
   c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. No washers shall be used.
   d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly as recommended by manufacturer.
   e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
4. Prestressed Concrete Cylinder Pipe Joints:
   a. Immediately before making the joint, completely clean the bell and spigot surfaces to be jointed.
   b. Apply a lubricant supplied by the pipe manufacturer to the sealing surfaces of the bell and spigot and the gasket. After lubrication, install the gasket in the spigot groove and ensure that the stretch in the gasket is equalized.
   c. After the pipe is lowered into place, align the spigot and bell so that the spigot will squarely enter the bell.
   d. Before the joint is fully assembled, check the position of the gasket in the bell using methods recommended by the pipe manufacturer and approved by the ENGINEER.
   e. If the gasket is found to be in the correct position around the entire circumference of the bell, remove temporary joint stoppers, if used, and shove the pipe completely home. If the gasket is not in the proper location, the joint shall be opened and reinstall using a new gasket.
   f. Where a joint opening is required to make a grade or alignment adjustment, the joint shall be installed completely closed first, then opened as necessary on one side. Joint openings shall not be greater than 75 percent of the maximum openings recommended by the pipe manufacturer.

g. Strap a diaper to the outside of the completed joint straddling the external joint recess. Pour a grout mix consisting of Portland cement and sand in proportions recommended by the pipe manufacturer to completely fill the external joint recess. In lieu of the joint diaper, may with written approval of the pipe manufacturer, use a polyurethane foam joint protector, with unhydrated Portland cement dispersed throughout the protector. The protector shall have the cross-sectional shape required for the type of joint being installed and shall be formed in a loop to fit the size of pipe on which it is to be used.

h. Point interior joint recess of all pipe 24-inches in diameter and larger with Portland cement/sand mortar mixed in proportions recommended by the pipe manufacturer. Strike off grout smooth with the interior face of the pipe. For pipes 20-inches in diameter and smaller which convey sewage or non-potable water, the interior surfaces of the steel joint ring shall be protected by a flexible mastic joint filler applied to the bell socket just prior to joining the pipe such that the mastic squeezes out to fill the internal joint recess.

i. Maintain a sufficient quantity of joint lubricant, gaskets, joint diapers and joint fillers at the site of the Work at all times.

j. Do not use gaskets which have been scored or otherwise damaged.

5. Steel Pipe Joints:

a. Joints in steel pipe shall be butt welded, flanged, or threaded joints, except that flexible couplings, mechanical couplings, or flanged connections shall be provided where shown on the Drawings.

b. Welding shall conform to the requirements of AWWA C 206. Pipe 36-inches in diameter and larger shall be welded both inside and outside of the pipe.

1) Submit documentation that all welders have been qualified in accordance with ASME Boiler and Pressure Vessel Code Section IX or American Welding Society Structural Welding Code D1.1, Section 5, whichever is required. Submit current certificates for the ENGINEER'S review.

c. After welding, the joint and the surrounding damaged or uncoated area shall be coated with the same material and to the same thickness as the shop applied coating.

d. Additional Welding Requirements:

1) On pipe lines specified to be welded, all joints between sections of pipe and between pipe and fittings 2-inches and larger shall be electric arc welded, and all joints on pipe 1-1/2 inches and smaller shall be gas welded. Entire responsibility for the quality of the welding belongs to CONTRACTOR.

a) Conduct tests not only of the welding procedure used by his organization to ensure welds that will meet the required tests, but also of the welding operators to determine the ability of the operators to make sound welds under standard conditions.

b) Be thoroughly familiar with ANSI B 31.1, and American Welding Society Standard B3.0.

c) Be capable of performing all welding operations required for construction and installation of the piping systems.

2) Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform

with the applicable portions of ANSI B 31.1 and American Welding Society Standard B3.0, and also as outlined below.

3) Examining Welder: Each welder shall be examined at the job site by CONTRACTOR in the presence of the ENGINEER to determine the ability of the welder to meet the qualifications required. Welders for piping shall be tested for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be:
   a) Allowed to weld only in the position in which the welder is qualified.
   b) Required to identify the weld with the specific code marking signifying the name and number assigned.
4) Examination Results: ENGINEER shall be provided with a listing of names and corresponding code markings. Where a welder fails to meet the prescribed welding qualifications, that welder shall be retested and, if the welder fails the second test, the welder shall be disqualified for work on the project.

e. For threaded joints, use standard, right hand tapered full depth threads on steel piping and apply an approved joint compound to the male threads only, before installation. Remove all cuttings and foreign matter from the inside of the pipe. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.

6. Thermoplastic Pipe Joints:
   a. Solvent Cement Joints:
      1) Bevel pipe ends and remove all burrs before making joints. Clean both pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40°F nor in wet conditions.
      2) Use solvent cement15 supplied or recommended by the pipe manufacturer.
      3) Apply joint primer and solvent cement and assemble joints in strict accordance with the recommendations and instructions of the manufacturer of the joint materials and the pipe manufacturer.
      4) Observe safety precautions with the use of joint primers and solvent cements. Allow air to circulate freely through pipelines to permit solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.
   b. Threaded Joints:
      1) Cut pipe square and smooth and remove burrs or raised edges with a knife or file. Hold pipe firmly in a pipe vise. Protect pipe at the point of grip by inserting a rubber sheet or other material between the pipe and vise. Thread pipe in accordance with the pipe manufacturer's recommendations. Brush threads clean of chips and ribbons. Then starting with the second full thread, and continuing over the thread length, wrap Teflon thread tape in the direction of the threads. Overlap each wrap by one half the width of the tape. Screw the fitting or coupling onto the pipe and tighten by hand. Using a strap wrench only, further tighten the connection an additional one to two threads past tightness.
7. Copper Tubing Joints:
   a. Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony conforming to ASTM B 32.
   b. Ream or file pipe to remove burrs.

c. Clean and polish contact surfaces of joints.
d. Apply flux to both male and female ends.
e. Insert end of tube into full depth of fitting socket.
f. Heat joint evenly.
g. Form continuous solder bead around entire circumference of joint.
h. Runs shall contain unions at connections to equipment and at reasonable distances along the lengths of runs to permit convenient disassembly of piping and removal of equipment.

D. Installing Valves and Accessories:
1. Provide supports for large valves, flow meters and other heavy items as shown on the Drawings or required.
2. Install floor stands as shown on the Drawings and as recommended by the manufacturer.
3. Provide lateral restraints for extension bonnets and extension stems as shown on the Drawings and as recommended by the manufacturer.
4. Provide steel sleeves where operating stems pass through floor. Extend sleeves 2-inches above floor.
5. Position valve operators as shown on the Drawings. When the position is not shown on the Drawings, install the valve so that it can be conveniently operated and as approved by ENGINEER. Avoid placing operators at angles to the floors or walls.
6. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and down stream runs recommended by the manufacturer, unless specific location dimensions are shown on the Drawings. Position swing check valves so that they do not conflict with the discs of butterfly valves.

E. Unions:
1. Install dielectric unions wherever dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions at each piece of equipment, where shown on the Drawings, and where necessary to install or dismantle piping.

F. Eccentric Reducers: Use eccentric reducers where shown on the Drawings and where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

G. Transitions from One Type of Pipe to Another:
1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

H. Taking Existing Pipelines Out of Service:
1. Do not take pipelines out of service, unless specifically named below or approved by ENGINEER.
a. Refer to Section 01 14 16, Coordination with OWNER'S Operations.
2. Notify ENGINEER at least 48 hours prior to taking pipeline out of service.

I. Work on Existing Pipelines:
1. Cut or tap pipes as shown on the Drawings or required with machines specifically designed for this Work.

2. Install temporary plugs to keep out all dirt, water and debris.
3. Provide all necessary adapters, fittings, pipe and appurtenances required.

3.2 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown on the Drawings or specified.

B. Thrust restraint shall be accomplished by means of restrained pipe joints. Thrust restraints shall be designed for the axial thrust exerted by the test pressure specified in Section 33 14 10, Piping Systems.

C. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Restrain concrete pipe joints utilizing welded joints.
      b. Restrain ductile iron mechanical joint pipe utilizing tie rods and clamps or proprietary restrained joint system conforming to the requirements of Section 33 05 19, Ductile Iron Pipe.
      c. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
      d. Steel pipe shall have butt-welded joints, flanged joints, or flexible or mechanical coupling connectors. Provide tie rods connected to ears welded to the steel pipe for restraint at all flexible coupling connectors.

3.3 PAINTING

A. Field painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

3.4 TESTING OF PIPING

A. General:
   1. Test all piping as specified below, unless otherwise authorized by ENGINEER.
   2. Notify ENGINEER 48 hours in advance of testing.
   3. Provide all testing apparatus including pumps, hoses, gages, and fittings.
   4. Pipelines shall hold the specified test pressure for two hours.
   5. Repair and retest pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate.
   6. Test pressures required are at the lowest elevation of the pipeline section being tested, unless otherwise specified.
   7. Follow special test procedures below for gaseous chemical and liquid chlorine lines.
   8. Conduct all tests in the presence of the ENGINEER. Repeat tests in the presence of local authorities having jurisdiction, if required.

B. Schedule of Pipeline Tests:
   1. Test piping at the test pressure specified in Section 33 14 10, Piping Systems.
   2. For piping not included in Section 33 14 10, Piping Systems, the ENGINEER will notify CONTRACTOR, in writing, of the test pressure to be utilized.

C. Pressure Test Procedure:
   1. Ensure that all supports and restraint protection are securely in place.
   2. Fill section to be tested slowly with water and expel all air. Install cocks, if necessary, to ensure removal of air.
   3. Test only one section of pipe at a time.
   4. Apply specified test pressure required for two hours and observe pressure gage. Check carefully for leaks while test pressure is being maintained.

D. Leakage Testing:
   1. Conduct leakage test after satisfactory completion of pressure test.
   2. Allow concrete pipe to stand full of water at least 12 hours prior to starting leakage test.
   3. Allowable Leakage Rates (gallons per hour per 1000 feet per inch diameter):
      a. Concrete Pressure Pipe: 0.0.
      b. Copper, Steel, Ductile Iron, Thermoplastic, and all Other Piping: 0.0.
      c. Ductile Iron Pipe with Mechanical Joints: 0.0.
   4. Leakage Test Procedure:
      a. Examine exposed pipe, joints, fittings and valves. Repair visible leakage or replace the defective pipe, fitting or valve.
      b. Refill the line under test to reach the required test pressure.
      c. Provide a test container filled with a known quantity of water at the start of the test. Attach the test pump suction to the test container.
      d. Pump water from the test container into the line with the test pump to hold the specified test pressure for the test period. Water remaining in the container shall be measured and the amount used during the test shall be recorded on the test report.
      e. Perform all repair, replacement, and retesting required because of failure to meet testing requirements.
      f. Leakage shall be less than rate specified above.

3.5 TESTING OF DRAINAGE PIPING

A. General:
   1. Test all drainage piping installed under this Section.
   2. Provide all testing apparatus required.
   3. Notify ENGINEER 48 hours in advance of test.
   4. Conduct all tests in presence of ENGINEER.

B. Procedures:
   1. Perform test on entire system or on individual sections as approved by ENGINEER.
   2. Completely seal all openings except highest opening in system or section to be tested.
   3. Fill with water completely and test with at least ten feet of water above highest point.
   4. Allow water to stand in system for at least 15 minutes. Inspect for leaks and repair all leaks found. Retest repaired sections.

3.6 CLEANING

A. Cleaning:
   1. Thoroughly clean all piping and flush prior to placing in service in a manner approved by ENGINEER.
   2. Piping 24-inches in diameter and larger shall be inspected from inside and all debris, dirt and foreign matter removed.

3.7 DISPOSAL OF WATER

A. Provide suitable means for disposal of test and flushing water so that no damage results to facilities or waterways.

B. Means of disposal of test and flushing water shall be subject to the approval of ENGINEER, local governing authorities and regulatory agencies.

C. Responsibility for any damages caused by the water disposal operations belongs to CONTRACTOR.

3.8 IDENTIFICATION OF PIPING

A. Pipe Identification Markers and Arrows:
   1. Product and Manufacturer: Provide one of the following:
      a. Brady B-500 vinyl cloth self sticking arrows and markers except on insulated pipe. Brady B-350 perma-code film self sticking arrows and markers on pipe insulation.
      b. Equivalent products as made by Seton Name Plate Corporation.
      c. Or equal.
   2. Install markers and arrows at following locations:
      a. At intervals not exceeding 50 feet along continuous runs of pipe.
      b. Wherever pipes pass through walls, floors or panels.
      c. At each valve or equipment connection.
      d. At each branch where it connects to a main line.

+ + END OF SECTION + +

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SECTION 40 05 61

GATE VALVES, OPERATORS AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install all gate valves, operators and appurtenances complete and operational as shown on the Drawings and as specified.
   2. The Work includes, but is not necessarily limited to, all valves required for buried, exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation and site utilities.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each gate valve shall be the product of one manufacturer.

B. Unit Responsibility:
   1. Unit Responsibility shall assigned by CONTRACTOR as specified in Section 11 00 00, General Equipment Provisions.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.4, Cast Iron Fittings.
   3. ASTM A 48/A 48M, Specification for Gray Iron Castings.
   4. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   5. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   6. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   7. ASTM A 436, Specification for Austenitic Gray Iron Castings.
   8. ASTM A 536, Specification for Ductile Iron Castings.
   9. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.

10. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
11. AWWA C500, Gate Valves for Water and Sewerage Systems.
12. AWWA C509, Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewerage Systems.
13. AGMA Standards.
14. NEMA, National Electrical Manufacturer's Association.
15. NSF 61, Drinking Water System Components-Health Effects.
16. Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

1.3 SUBMITTALS

A. Certificate of Unit Responsibility attesting that CONTRACTOR has assigned, and the supplier accepts unit responsibility in accordance with the requirements of this Section and Section 11 00 00, General Equipment Provisions.

B. Shop Drawings: Submit for approval the following:
   1. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
   2. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
   3. Deviations from Contract Documents.
   4. Engineering data including dimensions, materials, size and weight.
   5. Fabrication, assembly, installation and wiring diagrams.
   6. Control characteristics of modulating valves.
   7. Certificates of compliance with AWWA Standards, where applicable.
   8. Corrosion resistance information to confirm suitability of the valve materials for the application. Information on chemical resistance of elastomers shall be furnished from the elastomer manufacturers.
   9. Power and control wiring diagrams, including terminals numbers for electric actuators.
   10. Complete manufacturer's nameplate data of valves and electric actuators.
   11. Special tools list.
   12. C_V values and headloss curves.

C. Calculations:
   1. Sizing of operating mechanism with extension stems.
   2. Sizing of gear actuators.
   3. Sizing of anchor bolts.

D. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

E. Shop Tests:
   1. Test motor operated valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.
   2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.
   3. All gate valves 12” and larger shall be pressure tested in both directions prior to installation of have factory certification that all valves have been tested in both directions to rated pressures.

F. Certificates: Where specified or otherwise required by ENGINEER, submit test certificates.
   1. Submit Certificate of Compliance with NSF/ANSI 61 standard or with Arizona Administrative Code R18-4-119, in accordance with Section 11 00 00 requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer’s instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer’s recommendations for long term storage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Valves shall have manufacturer’s name and working pressure cast in raised letters on valve body.
   2. Manual valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.
   3. Manually operated valves, with or without extension stems, shall require not more than a 40-pound pull on the manual operator to open or close a valve against the specified criteria. The gear actuator and the valve components shall be able to withstand a minimum pull of 200-pounds on the manual

operator and an input torque of 300-foot pounds to an actuator nut. Manual operators include a T-handle wrench.

4. Unless otherwise specified, all flanged valves shall have ends conforming to ANSI B16.1. The pressure class of the flanges shall be equal to or greater than specified pressure rating of the valves.
5. Unless otherwise specified, bronze gate valves shall be provided with integral resilient seats.
6. Iron body valves shall be provided with screwed-on seat rings. Valves shall be of the non-rising stem type.
7. All nuts, bolts, studs, and washers that are to be submerged, buried, and/or contained inside either a below grade or above grade vault, manhole, etc., shall be constructed from ASTM F593, Type 316 stainless steel.
8. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
9. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
10. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
11. Bolts and nuts shall have hexagon heads and nuts.
12. All materials of construction of the valves shall be suitable for the applications as shown on the Drawings.
13. Protect wetted parts from galvanic corrosion due to contact of two different metals.
14. Gasket material and installation shall conform to manufacturer's recommendations.
15. Identification: Identify each valve 4-inches and larger with a stainless steel manufacturer's nameplate stamped with the approved designation. Manufacturer's nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
16. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section shall require NSF/ANSI 61, drinking water system components health effects, approval or comply with Arizona Administrative Code R18-4-119, standards for additives materials, and equipment.

B. Gate Valves:
   1. 3-Inch Diameter and Larger:
      a. General:
         1) Provide resilient wedge type valves conforming to AWWA C500 and as specified herein.
         2) Sizes:
            a) Non-Rising Stem (NRS): 3-inch through 48-inch.
            b) Outside Screw and Yoke (OS&Y) Rising-Stem: 3-inch through 12-inch.
         3) Type:
            a) Provide NRS valves.
            b) Provide position indicators for NRS valves used for interior service.

4) Rated Working Pressure:
   a) Valves 12-Inches and Smaller: 200 psig.
   b) Valves 16-Inches and Larger: 150 psig.
5) Maximum Fluid Temperature: 150°F.
6) Provide tongue-and-groove guides for solid-wedge valves.
7) Provide rollers and tracks for horizontal 16-inch and larger double disc valves.
8) Provide double disc valves with minimum four point wedging mechanism.

b. Materials of Construction: All materials of construction shall conform to AWWA C500 and shall be as follows for various valve components:
   1) Body, Bonnet, Stuffing Box and Discs: Gray iron or ductile iron.
   2) Seat and Disc Rings: Bronze.
   3) Stem and Stem Nut: Bronze.
   4) Disc Pin and Side Spreader: Bronze.
   5) Top and Bottom Wedge Nuts: Cast iron with integrally cast bronze bushing.
   6) Guide Contacts for 16-Inch and Larger Valves: Bronze.
   7) Rollers and Tracks: Bronze.
   8) All internal and external bolting and other hardware including pins, set screws, studs, bolts, nuts and washers: Type 316 stainless steel.
   9) All Rubber Items: Buna-N or other synthetic rubber suitable for the application.

c. Unless otherwise shown on the Drawings or specified, exposed valves shall have flanged ends conforming to ANSI B16.1, Class 125. Buried valves shall be provided with flanged ends with mechanical joint adapters. All bolts shall be Type 316 stainless steel.

d. Below grade gate valves shall be furnished with valve boxes, nut operated extension stems and tee wrenches, as required.

e. Shop Painting:
   1) Interior metal surfaces of cast iron valves, except finished or bearing surfaces, shall be shop painted with two coats of a NSF 61 approved epoxy coating applied in accordance with the manufacturer's recommendations.
   2) Exterior surfaces of the valves shall be shop painted as specified hereinafter under Article 2.8, below.

f. Testing:
   1) Test all valves in the shop in conformance with the requirements of AWWA C500.

g. Gear Actuators for Manually Operated Valves:
   1) Provide gear actuators for the valves, conforming to AWWA C500.
   2) Size gear actuators for the following requirements.
      a) Maximum Differential Pressure Across Closed Valve: 60 psi.

h. Product and Manufacturer: Provide one of the following:
   1) Mueller Company.
   2) American Darling
   3) U.S. Pipe & Foundry Co.
   4) Or equal.

2.2 ELECTRIC ACTUATORS

A. Not applicable.

2.3 APPURTENANCES FOR EXPOSED VALVES

A. General:
   1. Where shown on the Drawings, provide extension stems and floorstands.

B. Extension Stems:
   1. Conform to the applicable requirements of AWWA C501 for sizing of the complete lifting mechanism.
   2. Extension Stems:
      a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
      b. Maximum Slenderness Ratio (L/R): 100.
      c. Minimum Diameter: 1.5 inch.
      d. Threads: ACME.
      e. Stem couplings shall be provided where stems are furnished in more than one piece. The couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
      f. A Type 316 stainless steel cap suitable for the square end of the valve stem shall be welded to the bottom of the extension stem.
   3. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
   4. Stem Guides:
      a. Material: Type 316 cast stainless steel with bronze bushing for stem.
      b. Maximum Stem Length between Guides: Seven feet.
      c. Stem guides shall be adjustable in two directions.
   5. Furnish stem cover of clear butyrate plastic or grade 153 Lexan with a cast adaptor for mounting cover to bench and floor stands. Furnish stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within the cover. Provide engraved stem cover with legible markings showing the gate position at 1-inch intervals and open and close limits of the gates.

C. Floor Boxes: Provide cast iron floor boxes for all valves which are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast iron covers and be fitted with bronze bushing.

2.4 ANCHOR AND MISCELLANEOUS MOUNTING BOLTS

A. All bolts, nuts and washers for connection of the valve appurtenances to concrete structure or other structural members shall be obtained from the valve manufacturer, and shall be of ample size and strength for the purpose intended. Anchor bolts shall be hooked or adhesive type and shall be Type 316 stainless steel. Anchor bolts shall conform to the requirements of Section 03 15 19 Anchorage in Concrete.

B. Provide anchor bolts for stem guides of required strength to prevent twisting or sagging of the guides under load.

C. Provide bolts and washers of Type 316 stainless steel and nuts of Nitronic 60. The bolts shall have rolled threads and both bolts and nuts shall be electropolished to remove burrs.

D. Minimum Size of Anchor Bolts: 5/8-inch.

2.5 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09 90 00, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09 90 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with the manufacturer's instructions and recommendations.

B. Conform to appendices of AWWA Standards, where applicable.

C. Install all valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment or other causes.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation of the valves.

B. Conduct a functional field test on each valve in the presence of the ENGINEER to demonstrate that each valve operates correctly.

C. Demonstrate satisfactory opening and closing of valves at the specified criteria requiring not more than 40-pounds effort on the manual actuators.

D. Test ten percent valves of each type by applying 200-pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

3.3 MANUFACTURER'S SERVICE

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, 8 hours on site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the valves conform to requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 40 05 62

ECCENTRIC PLUG VALVES, OPERATORS AND APPURTENANCES

PART I - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install all eccentric plug valves, operators and appurtenances complete and operational as shown on the Drawings and as specified.
   2. The Work includes, but is not necessarily limited to, all valves required for exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation and site utilities.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each eccentric plug valve shall be the product of one manufacturer.

B. Unit Responsibility:
   1. Unit Responsibility shall assigned by CONTRACTOR as specified in Section 11 00 00, General Equipment Provisions.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.4, Cast Iron Fittings.
   3. ASTM A 48/A 48M, Specification for Gray Iron Castings.
   4. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
   5. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   6. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   7. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   8. ASTM A 436, Specification for Austenitic Gray Iron Castings.
   9. ASTM A 536, Specification for Ductile Iron Castings.
   10. ASTM A 743/A 743M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

11. ASTM A 2472, Specification for Nickel-Copper Alloy Plate, Sheet and Strip.
12. ASTM B 98/B 98M, Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
13. ASTM B 127, Specification for Nickel-Copper Alloy Plate, Sheet and Strip.
14. AWWA C540, Power Actuating Devices for Valves and Sluice Gates.
15. AGMA Standards.
16. NEMA, National Electrical Manufacturer's Association.
17. National Electrical Code (NEC) current adoption.
18. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A Certificate of Unit Responsibility attesting that CONTRACTOR has assigned, and the supplier accepts unit responsibility in accordance with the requirements of this Section and Section 11 00 00, General Equipment Provisions. No other Submittal material will be reviewed until the certificate has been received and conforms to the specified requirements.

B. Shop Drawings: Submit for approval the following:
1. Comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
2. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all eccentric plug valves and appurtenances.
3. Deviations from Contract Documents
4. Engineering data including dimensions, materials, size and weight.
5. Fabrication, assembly and installation drawings.
6. Certificates of compliance with AWWA Standards, where applicable.
7. Corrosion resistance information to confirm suitability of the eccentric plug valve materials for the application. Information on chemical resistance of elastomers shall be furnished from the elastomer manufacturers.
8. Complete manufacturer’s nameplate data of eccentric plug valves.
9. Special tools list.
10. C_V values and headloss curves.
11. Calculations:
    a. Sizing of operating mechanism with extension stems.
    b. Sizing of gear actuators.
    c. Sizing of anchor bolts.

C. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

D. Shop Tests:
1. Test motor operated eccentric plug valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.

2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.

E. Certificates: Where specified or otherwise required by ENGINEER, submit test certificates.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.
1. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. Handle all eccentric plug valves and appurtenances very carefully. Eccentric plug valves which are cracked, dented or otherwise damaged or dropped will not be acceptable.

C. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long term storage.

PART 2- PRODUCTS

2.1 MATERIALS

A. General:
1. Eccentric plug valves shall have manufacturer's name and working pressure cast in raised letters on valve body.
2. Manual eccentric plug valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.
3. Manually operated eccentric plug valves, with or without extension stems, shall require not more than a 40-pound pull on the manual operator to open or close a valve against the specified criteria. The gear actuator and the eccentric plug valve components shall be able to withstand a minimum pull of 200-pounds on the manual operator and an input torque of 300-foot pounds to an actuator nut. Manual operators include handwheel, chain, crank, lever and a T-handle wrench.
4. Unless otherwise specified, all flanged eccentric plug valves shall have ends conforming to ANSI B16.1. The pressure class of the flanges shall be equal to or greater than the specified pressure rating of the valves.
5. All bolts, nuts and studs on or required to connect buried or submerged valves shall be Type 316 stainless steel.
6. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
7. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.

8. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
9. Bolts and nuts shall have hexagon heads and nuts.
10. All materials of construction of the eccentric plug valves shall be suitable for the service identified in Section 33 14 10, Piping Systems, and as shown on the Drawings.
11. Protect wetted parts from galvanic corrosion due to contact of two different metals.
12. Gasket material and installation shall conform to manufacturer's recommendations.
13. Identification: Identify each eccentric plug valve 4-inches and larger with a stainless steel manufacturer's nameplate stamped with the approved designation. Manufacturer's nameplate shall be permanently fastened to valve body at the factory.
14. All eccentric plug valves for digester gas service shall be suitable for gas having the following composition by percent volume and other characteristics:
    a. Methane: 60 to 70 percent.
    b. Carbon Dioxide: 30 to 35 percent.
    c. Nitrogen: 0 to 50 percent.
    d. Hydrogen Sulfide: 0 to 0.2 percent.
    e. Gas Temperature: 0° to 140°F.
    f. Relative Humidity: 100 percent.

B. Eccentric Plug Valves:
    1. General:
        a. Non-lubricated eccentric type plug valves shall be installed where flow through the valve will be in only one direction.
        b. Eccentric plug valve shall have flanged ends. Flanges shall be faced and drilled to ANSI B16.l, Class 125.
    2. Eccentric Plug Valves:
        a. Valves shall have a valve port area of a minimum 80 percent of the full pipe area. Special application eccentric plug valves shall be provided with a port area of 100 percent of full pipe area as shown on the Drawings.
        b. Valves shall be rated for a minimum working pressure of 150 psig.
        c. Exposed valve flanges shall be faced and drilled in accordance with ANSI B16.1.
        d. Valve bodies shall be of cast iron conforming to ASTM A 126, Class B. Valve seats shall be of welded-in 90 percent nickel alloy, or Monel, a minimum of 1/8-inch thick conforming to ASTM B 127.
        e. Valves shall be furnished with replaceable stainless steel sleeve-type bearings in the upper and lower journals. These bearings shall comply with the applicable sections of AWWA C507 and AWWA C504. Bearings shall be of sintered, oil impregnated permanently lubricated Type 316 stainless steel for valves 12-inch and smaller. Bearings shall be ASTM A 743/A 743M Grade CF-8M, ANSI Type 316 stainless steel for Teflon coated Type 316 stainless steel for valves 14-inches and larger.
        f. Shaft seals shall be of the multiple V-ring type, externally adjustable, replaceable without removing the bonnet or actuator from the valve, repackable under pressure and shall comply with the applicable sections

of AWWA C504 and AWWA C507. Packing shall be adjustable chevron type replaceable without disassembling the valve for aboveground valves.

g. Eccentric plug valves for liquid service shall have a balanced plug coated with a vulcanized resilient isobutene-isoprene solidly bonded to a semi-steel core, as required, to assure low torque and drip-tight shutoff, suitable for bi-directional shutoff, with sewage, grit, sludge, potable and non-potable water operating at a temperature of 250°F.
h. Eccentric plug valves for digester gas and centrate/decant service shall be provided with drilled, tapped and plugged taps (1/8-inch P.T.F. SAE thread) in the upper and lower journal of 4-inch through 12-inch sizes, and provide gas service nitrile-butadiene plug facings on a Type 316 stainless steel plug and gear actuators designed for 50 psi minimum line pressure. Digester gas service valves 4-inch and larger shall have worm gear operators.
i. Products and Manufacturers: Provide one of the following:
    1) DeZurik Corporation.
    2) Val-Matic Valve & Mfg. Corp.

3. All Eccentric Plug Valves:
    a. All valves 6-inches in diameter and larger and all manually operated eccentric plug valves installed more than five feet above the operating floor regardless of size, shall be equipped with a geared operator.
    b. Manually operated valves smaller than 6-inches diameter installed five feet or less above the operating floor shall be lever wrench operated.
    c. Size gear actuators for valves 8-inch and smaller for 175 psig differential pressure.
    d. Size gear actuators for valves larger than 8-inch for the following maximum differential pressures:
        1) Valve Size and Location: See Drawings.
        2) Maximum Differential Pressure across Closed Valve: Manufacturers' recommendations.
    e. Design the actuators to hold the valves in any intermediate position without creeping or vibrating.
    f. Provide a valve position indicator on each actuator. Provide stop-limiting devices for open and closed position.
    g. Provide an adjustable stop to adjust the seating pressure.
    h. Make packing accessible for adjustment without requiring the removal of actuator from the valve.
    i. The diameter ratio of the handwheel or the chainwheel and the gear sector shall be less than two.
    j. Provide each actuator with gearing totally enclosed.
    k. The operator shaft and the gear sector shall be supported on permanently lubricated bronze bearings.
    l. Provide metal encased spring loaded seals in top and bottom covers of the gear housing.
    m. Actuators shall be designed to produce the indicated torque with a maximum pull of 40-pounds on the handwheel or chainwheel and a maximum input of 150-foot pounds on operating nuts, both for seating and unseating heads equal to the maximum differential pressure.
    n. Products and Manufacturers: Provide one of the following:
        1) Bettis G Series Pneumatic Actuators.

2) Or Approved Equal.

o. The actuators shall receive air from air compressor. Install Instrumentation Air System cabinet involving air filter regulator, solenoid valve, position transmitter, and other accessories recommended by the valve and actuator provider. See Drawings for additional information on the cabinet.

p. All actuator components between the input and the stops shall be designed to withstand, without damage, a pull of 200-pound for handwheel or chainwheel actuators and an input torque of 300-foot pound for operating nuts when operating against the stops.

r. Materials of Construction:
   1) Housing: Cast Iron, ASTM A 126, Class B.
   2) Gear Sector: Ductile Iron, ASTM A 536.
   3) Worm Gear: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35 to 45.
   4) All Bearings: Bronze oil impregnated.
   5) All Hardware including Bolts, Nuts, Washers, Set Screws and Pins: Type 316 stainless steel.

s. Valves higher than five feet above the operating floor:
   1) Chainwheels, sprockets and Type 304 stainless steel chain shall be provided for gear operated valves mounted more than five feet above the operating floor.
   2) Chain shall extend to three feet above the operating floor.
   3) Gearing shall be enclosed in a semi-steel housing and shall be suitable for running in a lubricant, with seals provided on all shafts to prevent entry of dirt and water into the operator.
   4) Operator shaft and the gear quadrant shall be supported on permanently lubricated stainless steel bearings.
   5) Operator shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque.
   6) Exposed nuts, bolts and washers shall be zinc plated.

t. Where lever wrench operated valves are required, each valve shall be furnished with its own lever wrench operator.

u. Extension Bonnets: Where required, extension bonnets shall be provided. Extension bonnet shall be of steel or cast iron, with carbon steel stems, constructed so that when connected to the valve the extension bonnet shall be vertical, and designed to fully support the operator and stem extension. Exposed extension stems shall be of Type 316 stainless steel. Intermediate bearings shall be provided on the extension bonnet, as required.

v. Valve packing adjustment on non-submerged valves shall be accessible without removing the actuator from the valve.

w. Shop Painting:
   1) Interior ferrous metal surfaces of the valve except finished or bearing surfaces and the plug, shall be shop painted with two coats of an approved two component coal tar epoxy coating applied in accordance with the manufacturer's recommendations.
   2) Exterior surfaces of the valve and operator shall be shop painted as specified hereinafter under Article 2.8, below.

4. Air Compressor System:

The air compressor package shall include an air-cooled, two-stage, oil lubricated reciprocating type air compressor mounted on one air receiver and piped and wired to the control panel.

1) The air compressor shall be the standard product of a manufacturer as described in this Section, who is regularly engaged in the design and construction of fully automatic air compressor systems.
2) The air compressor package will be provided suitable for outdoor/weatherproof applications, i.e, NEMA 4 equipment and controls.
3) A Totally Enclosed Fan Cooled (TEFC) motor shall drive the compressor and shall be adequate to drive each compressor continuously at full-rated output. Motor shall be at least 7.5 hp. Power supply shall be 480 volts, 3 phase and 60 hertz.
4) System supplier shall determine the compressor volumetric capacity and discharge pressure. Motor shall be non-overloading at rated flow and pressure.
5) Compressor unit shall include a totally enclosed crankcase of cast iron, separate detachable deep finned cylinders, matched balanced pistons, separately removable valve housing, low oil switch and a direct reading pressure gauge. The low oil switch shall shut down the compressor if the oil level is too low. The switch shall not reset without adding oil.
6) UL listed and FM approved.
7) Dedicated to fire protection service.
8) Mount pump and motor on common base plate with coupling and guard.
9) Provide for mounting on wall, floor, or pipe.
10) Capacity: Capable of restoring normal air pressure in system within 20 minutes.
11) Field adjustable cut-in and cut-out pressure switch.
12) Air compressor accessories:
    a. Air compressor system should be duplex type and shall have a 120 gallon minimum capacity tank, compressed air filter, oil water separator, noise muffler and other accessories as recommended by the air compressor manufacturer.
    b. Inlet silencer and filter.
    c. Discharge air and water separator, with relief valve, gauge glass and ball float valve.
    d. Discharge check valve, isolation valve, and pressure gauge.
    e. Pressure switch: HIGH/LOW operation.
    f. Mounting hardware.
    g. Piping and fittings.
    h. Drip leg with drain valve to collect condensate, and keep it away from compressor.
    i. Desiccant dryer.
    j. Provide dryer when compressed air will be in piping exposed to freezing.
    k. Oil/water separator
13) The air compressor shall be supplied with a control panel as follows:
    a. Panel shall be NEMA 4X rated, stainless steel enclosure with padlockable hinged cover.

b. Panel shall be shipped loose for installation by the Contractor. Panel shall be suitable for rack mounting.
    i. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite. Control panel without an affixed UL 508A label shall be rejected and sent back to the factory.

c. Provide a single main incoming power circuit with thermal magnetic type circuit breaker main disconnect.
    i. Power supply shall be 480 VAC, 3-phase, 60Hz.
    ii. Limit load to maximum of 80 percent of circuit breaker rating.

d. Provide motor starter and motor starter circuit breaker with lockable handle through cabinet door.

e. Panel construction shall meet the applicable requirements of Division 16.

f. Panel shall be supplied with the following controls and door mounted indicators:
    i. Hand-Off-Automatic (HOA) switch for each compressor motor.
    ii. Green compressor OFF indicator lamp for each compressor motor.
    iii. Red compressor RUNNING indicator lamp for each compressor motor.
    iv. Amber low oil alarm indicator lamp
    v. Amber motor thermal overload indicator lamp for each compressor motor.
    vi. Other selector switches and pushbuttons to provide a complete, functional system.

g. Terminal blocks for interfacing interior and exterior panel wiring.
    i. Wire all auxiliary contacts to terminal points.

h. Remote control and indication interface with plant control system:
    i. Provide dry contact for remote indication of the following:
        1. Equipment in Hand for each compressor motor.
        2. Equipment in Auto for each compressor motor.
        3. Compressor Running for each compressor motor.
        4. Compressor Alarm for each compressor motor.

14) Control Description:

a. The air compressor shall start and stop automatically based on pressure in the air receiver.
    i. HOA switch:
    ii. In Hand: the compressor starts.
    iii. In Off: the compressor is off.

iv. In Auto: the compressor shall start automatically when the pressure in the air receiver drops below the pressure setpoint.

b. Interlocks:
   i. The compressor shall be shutdown if the surge tank low-low level alarm is active.
   ii. The compressor shall be shut down on high air receiver pressure.
   iii. The compressor shall be shutdown by motor thermal overload.

c. Dry contacts shall be provided in the panel for remote indication of running conditions for the compressor. The compressor shall be shutdown by motor thermal overload, or low oil level. An alarm condition shall energize a local alarm light.

d. Air compressor pump shall be sized properly to provide required air flow through each actuator. The valve and actuator supplier shall select the compressor volumetric capacity and discharge pressure. The capacity and discharge pressure selected shall be sufficient for operation.

e. The air receiver shall be a minimum of 120-gallon capacity and equipped with Pneumatic No Loss Drain Kit (PNLD).

f. Factory coating on air compressor, urethane polyester powder coat, 2-5 mils. Color shall be selected by Engineer.

g. Provide a prefabricated fiberglass or metal noise enclosure, as recommended by the compressor manufacturer, to meet City of Scottsdale Noise Ordinance (max 65 dB – 4' from property line). Color shall be as selected by City and Engineer to match existing site equipment enclosures.

h. Working pressure shall be 150 psi or higher.

q. Products and Manufacturers for Air Compressor: Provide one of the following:
   1) Ingersoll Rand, Two Stage Reciprocating Compressor (Model 2-2545E7.5 model).
   2) Or Approved Equal.

4. Eccentric Plug Valves - Guarantee:

ECCENTRIC PLUG VALVES - GUARANTEE

WHEREAS

of (Address)

, Telephone:

Herein called the "Valve Manufacturer" has furnished eccentric plug valves on the following Project:

City of Phoenix
(--1--)
(--2--)

OWNER: City of Phoenix

Guarantee Period: Five years Date of Final Acceptance:
Date of Expiration:

AND WHEREAS the Valve Manufacturer has contracted (either directly with the OWNER or indirectly as a subcontractor) to Guarantee said Valves against leaks and faulty or defective materials and workmanship for the designated Guarantee Period;

NOW THEREFORE the Valve Manufacturer hereby Guarantees, subject to the terms and conditions herein set forth, that during the Guarantee Period he will at his own cost and expense, make or cause to be made such repairs to or replacements of said Valves as are necessary to correct faulty and defective work, and as are necessary to maintain said Valves to operate as specified.

This Guarantee is made subject to the following terms and conditions:

1. Specifically excluded from this Guarantee are damages to the Valves caused by: a) lightning, and other unusual phenomena of the elements; b) fire. When the Valves have been damaged by any of the foregoing causes, the Guarantee shall be null and void until such damage has been repaired by the Valve Manufacturer, and until the cost and expense thereof has been paid by the OWNER or by another responsible party so designated.
2. During the Guarantee Period if the OWNER allows alteration of the Valves by anyone other than the Valve Manufacturer, including maintenance in connection with other Work, this Guarantee shall become null and void upon the date of said alterations. If the OWNER engages CONTRACTOR to perform said alterations, the Guarantee shall not become null and void, unless the Valve Manufacturer, prior to proceeding with said Work shall have notified the OWNER, in writing, showing reasonable cause for claim that said alterations would likely damage or deteriorate the Valves, thereby reasonably justifying a termination of this Guarantee.
3. The OWNER shall promptly notify the Valve Manufacturer of observed known or suspected, defects or deterioration, and shall afford reasonable opportunity for the Valve Manufacturer to inspect the valves, and to examine the evidence of such leaks, defects or deterioration.
4. This Guarantee is recognized to be the only Guarantee of the Valve Manufacturer on said Valves, and shall not operate to restrict or cut off the OWNER from other remedies and recourses lawfully available to him in cases of valves failures. Specifically, this Guarantee shall not operate to relieve the Valve Manufacturer of his responsibility for performance of the Valves, regardless of whether original contract was a contract directly with the OWNER or a subcontract with the OWNER'S CONTRACTOR.

IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, 20__.

Valve Manufacturer's Signature:

Typed Name:

As Its (position):

And has been countersigned by CONTRACTOR issuing the Valve Manufacturer's subcontract for said Valves:

Name of CONTRACTOR:

Date: Authorized Signature:

Typed Name:

As Its (position):

2.3 APPURTENANCES FOR EXPOSED VALVES

A. General:
   1. For valves located less than 5 feet-0 inches above the operating floor, provide levers on 4-inch quarter turn valves and handwheels on all other valves, unless otherwise shown on the Drawings or specified.
   2. For valves located at 5 feet-0 inches or more above the operating floor, provide chain operators.
   3. Where shown on the Drawings, provide extension stems and floorstands.

B. Handwheels:
   1. Conform to the applicable AWWA Standards.
   2. Material of Construction: Ductile iron or cast aluminum.
   3. Arrow indicating direction of opening and word "OPEN" shall be cast on the trim of the handwheel.
   4. Maximum Handwheel Diameter: 30-inches.

C. Chain Operators:
   1. For valves more than 5 feet-0 inches above the operating floor provide chain operators.
   2. Chains shall extend to three feet above the operating floor.
   3. A 1/2-inch stainless steel hook bolt shall be provided to keep the chain out of the walking area.
   4. Materials of Construction:
      a. Chain: Type 304 stainless steel.
      b. Chain wheel: Recessed groove type made out of bronze bushed with guides.
   5. Chain Construction:

a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends shall not be acceptable.

6. Provide geared operators where required to position chain wheels in vertical position.

D. Crank Operator:
   1. Crank operator shall be removable and fitted with a rotating handle.
   2. Maximum Radius of Crank: 15-inches.
   3. Materials:
      a. Crank: Cast iron or ductile iron.
      b. Handle: Type 304 stainless steel.
      c. Hardware: Type 304 stainless steel.

E. Extension Stems and Floorstands for Valves:
   1. Conform to the applicable requirements of AWWA C501 for sizing of the complete lifting mechanism.
   2. Bench and Pedestal Floorstands:
      a. For valves requiring extension stems, provide bench or pedestal floorstands with handwheel or crank as indicated. Make provisions for use of portable electric actuator for opening and closing of the valves.
      b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering the housing. A lubrication fitting shall be provided for grease. The base shall be machined.
      c. Materials of Construction:
         1) Housing: Cast-iron, ASTM A 126, Class B, or steel.
         2) Lift Nut: Cast bronze, ASTM B 98/B 98M.
         3) Grease Fitting: Stainless steel.
         4) All Bolting: Type 316 stainless steel.
   3. Wall brackets for floorstands shall be of Type 316L stainless steel construction.
   4. Extension Stems:
      a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
      b. Maximum Slenderness Ratio (L/R): 100.
      c. Minimum Diameter: 1.5-inch.
      d. Threads: ACME.
      e. Stem couplings shall be provided where stems are furnished in more than one piece. The couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
      f. A Type 316 stainless steel cap suitable for the square end of the valve stem shall be welded to the bottom of the extension stem.
   5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
   6. Stem Guides:
      a. Material: Type 316 cast stainless steel with bronze bushing for stem.
      b. Maximum Stem Length between Guides: Seven feet.
      c. Stem guides shall be adjustable in two directions.

F. Floor Boxes: Provide cast-iron floor boxes for all valves which are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.6 PAINTING

A. Clean and shop prime coat and shop finish coat ferrous metal surfaces of equipment in accordance with the requirements of Section 09 90 00, Painting and Coating.

B. Coat machined, polished and non-ferrous surfaces including gears, bearing surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting shall conform to the requirements under Section 09 90 00, Painting and Coating.

D. Certify, in writing, that the shop primer and coating system is compatible with the finish coating system in accordance with Section 09 90 00, Painting and Coating.

2.7 INSPECTION AND WITNESS SHOP TESTS

A. Allow for inspection and witness testing of the following valves by the ENGINEER at the place of manufacturer:
   1. Valve Type: 16-inch Exposed Valves (6)
   2. Valve Sizes: 20-inch Exposed Valves (1)
   3. Valve Sizes: 24-inch Exposed Valves (2)
   4. Number of Valves to be Inspected and Witness Tested: 9

2.8 CONDUITS, CONDUCTORS, AND CONNECTIONS

A. Furnish and install all conduits, conductor, and connections for a turnkey system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with the manufacturer's instructions.

B. Conform to appendices of AWWA Standards, where applicable.

C. Install all valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves and equipment, and as approved by the ENGINEER. Orient chain operators out of the way of the walking areas. Mount valves so that indicator arrows are visible from floor level.

D. Install all valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment or other causes.

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3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation of the valves.

B. Conduct a functional field test on each valve in the presence of the ENGINEER to demonstrate that each valve operates correctly.

C. Demonstrate satisfactory opening and closing of valves at the specified criteria requiring not more than 40-pounds effort on the manual actuators.

D. Test ten percent valves of each type by applying 200-pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

3.3 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 4 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the eccentric plug valves and appurtenances conform to the requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 40 05 66

THERMOPLASTIC VALVES, OPERATORS AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install all thermoplastic valves, operators and appurtenances complete and operational as shown on the Drawings and as specified.
   2. The Work includes, but is not necessarily limited to, all types of valves required for buried, exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation, site utilities, insulation, heating, ventilating and air conditioning and plumbing.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each type of valve shall be the product of one manufacturer.

B. Unit Responsibility:
   1. Unit Responsibility shall assigned by the CONTRACTOR as specified in Section 11 00 00, General Equipment Provisions, to the individual valve and gate suppliers for the entire valve or gate assembly. A Certificate of Unit Responsibility shall be provided.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   2. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   3. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   4. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds.
   5. ASTM F 439, Specification for Socket-type, Chlorinated Poly (Vinyl Chloride)(CPVC) Plastic Pipe Fittings, Schedule 40.
   6. ASTM F 441, Specification for Chlorinated Poly (Vinyl Chloride)(CPVC) Plastic Pipe, Schedules 40 and 80.

7. ASTM F 493, Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride)(CPVC) Plastic Pipe and Fittings.
8. Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

1.3 SUBMITTALS

A All submittals are to be in compliance with the requirements of Section 01 33 00, Submittal Procedures.

B. Certificate of Unit Responsibility attesting that CONTRACTOR has assigned, and the supplier accepts unit responsibility in accordance with the requirements of this Section and Section 11 00 00, General Equipment Provisions. No other Submittal material will be reviewed until the certificate has been received and conforms to the specified requirements.

C. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
2. Deviations from the Contract Documents.
3. Engineering data including dimensions, materials, size and weight.
4. Fabrication, assembly and installation drawings.
5. Certificates of compliance with AWWA Standards where applicable.
6. Corrosion resistance information to confirm suitability of the valve materials for the application. Information on chemical resistance of elastomers shall be furnished from the elastomer manufacturers.
7. Complete manufacturer's nameplate data of valves.
8. Special tools list.
9. C_v values and headloss curves.

D. Calculations:
1. Sizing of operating mechanism with extension stems.
2. Sizing of gear actuators.
3. Sizing of anchor bolts.

E. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

F. Shop Tests:
1. Test motor operated valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.
2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all materials off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long term storage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. Valves shall have manufacturer's name and working pressure cast in raised letters on valve body.
2. Manual valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.
3. Unless otherwise specified, all flanged valves shall have ends conforming to ANSI B16.1, Class 125.
4. Buried valves shall have flanged ends with mechanical joint adapters and installed with a flanged adapter or have grooved mechanical couplings. All bolts shall be Type 316 stainless steel.
5. Buried valves shall be provided with adjustable two piece valve boxes and provided with extension stems, operating nuts and covers unless otherwise shown or specified. Extension stems shall terminate 12-inches below finished grade.
6. All bolts, nuts and studs on or required to connect buried or submerged valves shall be Type 316 stainless steel.
7. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
8. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
9. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B or ASTM A 354.
10. Bolts and nuts shall have hexagon heads and nuts.
11. Gasket material and installation shall conform to manufacturer's recommendations.

12. Identification: Identify each valve 4-inches and larger with a stainless steel manufacturer's nameplate stamped with the approved designation. Manufacturer's nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
13. All materials of construction of the valves shall be suitable for the applications as shown on the Drawings.
14. Responsibility to coordinate compatible materials of construction for all wettable parts of all valves for each process application belongs to CONTRACTOR. 15. All materials or products which can contact drinking water or a water treatment chemical furnished or installed under this section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval, or comply with Arizona Administrative Code R-18-4-119, Standards for Additives, Materials, and Equipment. Acceptable compatible materials of construction for wettable materials are as follows:

Process Fluid	Compatible Materials of Construction
Ferric Chloride	CPVC, Buna, EPDM, Teflon, Viton

B. CPVC Check Valves:
1. Check valves on CPVC piping shall be manufactured of chlorinated polyvinyl chloride (CPVC) material with seats and seals which are compatible with the process fluid.
2. CPVC shall be Type 4, Grade 1, in accordance with the requirements of ASTM D 1784.
3. Valves shall be true union type or flanged, rated for 100 psi service minimum, and shall be suitable for installation in either the horizontal or vertical plane.
4. Limit switches shall be provided for check valves as shown on the Drawings.
   a. The valve shall be provided with two SPDT limit switches for remote position indication.
   b. Limit Switch Rating: 15 amps, 120 VAC.
   c. Limit switches shall be provided in a NEMA 4X enclosure.
5. Product and Manufacturer: Provide one of the following:
   a. Nibco Incorporated.
   b. Hayward Manufacturing Company.
   c. ASAHI/America
   d. Spears
   e. Or equal.

C. CPVC Ball Valves:
1. Ball valves on CPVC piping shall be manufactured of chlorinated polyvinyl chloride (CPVC) material with seats and seals which are compatible with the process fluid.
2. CPVC shall be Type 4, Grade 1, in accordance with the requirements of ASTM D 1784.
3. Valves shall be true union type and rated for 150 psi service.
4. Limit Switches shall be provided for ball valves as shown on the Drawings.

a. The valves shall be provided with two SPDT limit switches for remote position indication.
b. Limit switch rating: 15 amps, 120 VAC.
c. Limit switches shall be provided in a NEMA 4X enclosure.

5. Product and Manufacturer: Provide one of the following:
a. Nibco Incorporated.
b. Hayward Manufacturing Company.
c. ASAHI/America
d. Spears
e. Or equal.

D. Basket Strainers:
1. Basket Strainers - Simplex or Duplex as shown on the Drawings:
a. End connections: 4-inches and larger, flanged; smaller than 4-inches, socket.
b. Body: chlorinated polyvinyl chloride (CPVC) with one 3/8-inch NPT body drain.
c. Screen:
1) Chlorinated polyvinyl chloride (CPVC).
2) Perforations: 1/16-inch.
3) Open area not less than six times the corresponding cross-sectional pipe area.
d. Strainer cover shall be removable without the use of tools.
e. Product and Manufacturer: Provide one of the following:
1) Hayward.
2) Or equal.

2.2 ELECTRIC ACTUATORS

A. Not applicable.

2.3 VALVE APPURTENANCES

A. Valve Boxes: Provide each buried valve with a valve box as follows:
1. Made of heavy pattern cast-iron, 2 piece adjustable telescoping type.
2. Lower section shall enclose operating nut and stuffing box and rest on bonnet.
3. Inside diameter shall be at least 4-1/2-inches.
4. Provide extension stem and operating nut.
5. Cover shall be heavy duty cast iron with direction to open arrow cast in.

2.4 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09 90 00, Painting and Coating. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09 90 00, Painting and Coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with the manufacturer's instructions.

B. Install all valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves and equipment, and as approved by the ENGINEER. Orient chain operators out of the way of the walking areas. Mount valves so that indicator arrows are visible from floor level.

C. Install all valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment or other causes.

D. For buried valve installations, set valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of the box, or to the undisturbed trench face if less than four feet.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation of the valves.

B. Conduct a functional field test on each valve in the presence of the ENGINEER to demonstrate that each valve operates correctly.

C. Demonstrate satisfactory opening and closing of valves at the specified criteria requiring not more than 40-pounds effort on the manual actuators.

D. Test ten percent valves of each type by applying 200-pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

3.3 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, minimum 8 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00,

Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the valves conform to requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

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SECTION 40 05 73

SPECIALTY VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install all specialty valves and appurtenances complete and operational as shown on the Drawings and as specified.
   2. The Work includes, but is not necessarily limited to, all types of valves required for buried, exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation, site utilities, insulation, heating, ventilating and air conditioning and plumbing.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each type of specialty valve shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI A13.1, Scheme for Identification of Piping Systems.
   2. ANSI/ASME A112.1.2, Air Gaps in Plumbing Systems.
   3. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   4. ANSI B16.4, Cast Iron Fittings.
   5. ANSI B40.1, Gauges-Pressure Indicating Dial Type-Elastic Element.
   6 ASTM A 48, Specification for Gray Iron Castings.
   7. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   8. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   9. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   10. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   11. ASTM A 436, Specification for Austenitic Gray Iron Castings.
   12. ASTM A 536, Specification for Ductile Iron Castings.
   13. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.

14. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds.
15. ASTM D 1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedulers 40, 80 and 120.
16. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
17. AWWA C500, Gate Valves for Water and Sewerage Systems.
18. AWWA C502, Dry-Barrel Fire Hydrants.
19. AWWA C503, Wet-Barrel Fire Hydrants.
20. AWWA C506, Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
21. AWWA C507, Ball Valves, 6-Inch Through 48-Inch.
22. AWWA C509, Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewerage Systems.
23. AWWA C512 Air-Release, Air/Vacuum and Combination Air Valves for Water Works Service
24. AGMA Standards.
25. ASSE 1003, Water Pressure Reducing Valves.
26. NEMA, National Electrical Manufacturer's Association.
27. NSF/ANSI 61, Drinking Water System Components Health Effects
28. Arizona Administrative Code Q18-4-119, Standards for Additive Materials, and Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
   2. Deviations from Contract Documents.
   3. Engineering data including dimensions, materials, size and weight.
   4. Fabrication, assembly, installation and wiring diagrams.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

C. Shop Tests:
   1. Test motor operated valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.
   2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.

D. Certificates:
   1. Where specified or otherwise required by ENGINEER, submit test certificates.
   2. Certificate of Compliance with NSF/ANSI 61 standard or with Arizona Administrative Code R18-4-119, in accordance with section 11 00 00

requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long term storage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Valves shall have manufacturer's name and working pressure cast in raised letters on the valve body or on a stainless steel manufacturer's nameplate stamped with the approved designation and permanently attached to the valve body.
   2. Manual valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.
   3. Unless otherwise specified, all flanged valves shall have ends conforming to ANSI B16.1. The pressure class of the flanges shall be equal to or greater than the specified pressure rating of the valves.
   4. Buried valves shall have flanged ends with mechanical joint adapters and installed with a flanged adapter or have grooved mechanical couplings. All bolts shall be Type 316 stainless steel.
   5. Buried valves shall be provided with adjustable two piece valve boxes and provided with extension stems, operating nuts and covers, unless otherwise shown or specified. Extension stems shall terminate 12-inches below finished grade.
   6. All bolts, nuts and studs on or required to connect buried or submerged valves shall be Type 316 stainless steel.
   7. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.

8. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
9. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
10. Bolts and nuts shall have hexagon heads and nuts.
11. Gasket material and installation shall conform to manufacturer's recommendations.
12. Identification: Identify each valve 4-inches and larger with a stainless steel manufacturer's nameplate stamped with the approved designation. Manufacturer's nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
13. All materials of construction of the valves shall be suitable for the applications as shown on the Drawings.
14. Protect wetted parts from galvanic corrosion due to contact of two different metals.
15. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, drinking water system components health effects, approval or comply with Arizona Administrative Code R18-4-119, standards for additives, materials and equipment.

B Hose Bibbs, Pipe Drains:
1. Valve:
   a. Type: Boiler drain globe valve, chrome plated.
   b. Material: Bronze body, screwed bonnet, renewable composition disc.
   c. End Connections: Hose thread outlet, male pipe thread or sweat inlet.
   d. Rating: 125 lbs. WOG.
2. Vacuum Breaker:
   a. Type: Non-removable, atmospheric.
   b. Materials: Brass body, stainless steel trim, silicone rubber diaphragm and disc.
   c. End Connections: Hose thread inlet and outlet.
3. Product and Manufacturer: Provide one of the following:
   a. Woodford Manufacturing Co.
   b. Nibco Incorporated
   c. Or Approved Equal.

C. Pipe Labels:
1. Type: Self-adhering, temperature resistant, waterproof, corrosion resistant.
2. Marker size, marker color, legend size, and legend color shall conform to ANSI A13.1.

D Quick Coupler Connections:
1. Type: Cam arms lock into adaptor groove.
2. Materials: Adaptor and Coupler:
   a. Body: Stainless steel.
   b. Cam arms: Stainless steel.
   c. Gaskets: Buna N.

3. Ends: Socket weld quick connect adaptor for connection to copper tubing; hose shank quick connect coupler.
4. Reference: MIL-C-27487.
5. Product and Manufacturer: Provide one of the following:
   a. Dover Corp.; OPW “Kamlok” series.
   b. Or equal.

E. Air Release, Air/Vacuum, and Combination Air Valves
1. All valves listed below shall meet AWWA C512, latest edition, Standard for Air-Release, Air/Vacuum and Combination Air Valves for Water Works Service.
2. Air Release Valves:
   a. Purpose: Valve is used to automatically release small pockets of accumulated air from a piping system while operating at a pressure greater than atmospheric. Valves shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure.
   b. Operation: Float actuated, with simple or compound lever mechanism. Small venting orifice discharges accumulated air or vapor to atmosphere with the system under pressure.
   c. Design Conditions:
      1) Air Pressure Release Rate: 10 cfm @ 10 psi differential
   d. Construction:
      1) Body: Ductile Iron.
      2) Float: Type 316 Stainless Steel ASTM A240.
      3) O-Ring: EPDM.
      4) Trim: Type 316 Stainless Steel ASTM A240.
      5) Valve Size/Conn: Inlet shall be 2-inch, flanged unless otherwise shown on the Drawings.
3. Air / Vacuum Valves:
   a. Purpose: Valve is used to automatically exhaust large quantities of air during pipeline filling, and to admit large quantities of air when the internal pressure drops below atmospheric.
   b. Operation: Float actuated valve with large orifice exhausts or admits air from the system.
   c. Design Conditions:
      1) Air Discharge (Fill/Vent) Rate: 10 cfm @ 150 psi
      2) Air Inlet Rate (Empty/Vacuum) Rate: 400 cfm @ 5 psi differential
   d. Construction:
      1) Manufacturer and Model:
         a. APCO
         b. Val-Matic
         c. ARI or Water Distribution approved equal
      2) Body: Ductile Iron.
      3) Float: Type 316 Stainless Steel ASTM A240.
      4) O-Ring: EPDM.
      6) Trim: Type 316 Stainless Steel ASTM A240.
      7) Inlet Size/Conn: Size and connection flanged unless otherwise shown on drawings.
      8) Outlet Size/Conn: Size and connection (threaded, flanged, hooded)

as shown on Drawings.

2.2 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09 90 00, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09 90 00, Painting.

C. All bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09 90 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with manufacturer's instructions and recommendations.

B. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by ENGINEER.

C. Unless otherwise approved by the ENGINEER, install all valves plumb and level. Install valves free from distortion and strain caused by misaligned piping, equipment or other causes.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation.

B. Conduct functional field test of each valve in presence of ENGINEER to demonstrate that each part and all components together function correctly.

3.3 MANUFACTURER'S SERVICE

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, 8 hours per visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third

visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the valves conform to the requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 40 05 73.25

PIPING SPECIALTIES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all piping specialties and accessories. Included, but not limited to, are: flexible couplings, mechanical couplings, flanged and harnessed adapters, and expansion joints.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar types of piping specialties specified and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each type of piping specialty and accessory shall be the product of one manufacturer.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on each type of coupling, adaptor and expansion joint to be furnished. Submit and coordinate these with Shop Drawings required for piping systems. Comply with requirements of Section 01 33 00, Submittals, and Section 01 33 23, Shop Drawing Procedures.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Couplings: Unless otherwise specified, piping 2-inches in diameter and larger passing from concrete to earth shall be provided with two pipe couplings or flexible joints as specified within 2-feet or one pipe diameter of the structure, whichever is greater.
   1. Sleeve Type, Flexible Couplings:

a. Pressure and Service: Same as connected piping.
b. Material: Carbon steel for carbon steel and exposed ductile iron piping systems, or stainless steel for stainless steel and buried or submerged ductile iron piping systems.
c. Gasket: Suitable for wastewater service, or high temperature air service.
d. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
e. Harnessing:
   1) Harness couplings to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 33 14 10, Piping Systems.
   2) Adjacent flanges shall be tied with bolts of corrosion resistant alloy steel. Provide flange mounted stretcher bolt plates as shown on the Drawings and to be designed by manufacturer, unless otherwise approved by the ENGINEER.
   3) Conform to dimensions, size, spacing and materials for lugs, bolts, washers and nuts as recommended by manufacturer and approved by ENGINEER for the pipe size, wall thickness and test pressure required. However, the following minimum bolting shall be provided, unless otherwise approved by the ENGINEER.

Pipe Diameter (Inches)	Number of Bolts	Bolt Diameter (Inches)	At (Degrees)
4	2	5/8	180
6-8	2	3/4	180
10-12	2	7/8	180 or 250
14-20	4	1	190
24-48	4	1	90
54	4	1	250
60	4	1-1/4	90

f. Remove pipe stop, unless otherwise shown on the Drawings or specified.
g. Product and Manufacturer: Provide one of the following:
   1) Style 38, as manufactured by Dresser Industries.
   2) Ford FC2A
   3) Smith-Blair or Water Distribution approved equal.

2. Flanged Adapters:
   a. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
   b. Pressure and Service: Same as connected piping.
   c. Material: Cast iron or steel.
   d. Gasket: suitable for wastewater and digester gas service and can withstand the specified temperature. EPDM gaskets for 250°F air service.
   e. Bolts and Nuts: Type 316 stainless steel.
   f. Harnessing:
      1) Harness adapters to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 33 14 10, Piping Systems.
      2) For adapters 12-inch diameter and less, provide 1/2- inch minimum stainless steel anchor studs installed in a pressure tight anchor boss.

Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by manufacturer; however, the following minimum anchor studs shall be provided, unless otherwise approved by ENGINEER.

a) 6-inch diameter and less: Two.
b) 8-inch diameter and less: Four.
c) 10-inch diameter and less: Six.
d) 12-inch diameter and less: Eight.

3) For adapters larger than 12-inch diameter, provide split-ring harness clamps with a minimum of four Type 316 stainless steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, sizes, spacings and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.
4) Harness couplings to restrain pressure piping.
5) Test pressures for pressure pipe lines shall conform to the requirements of Section 33 14 10, Piping Systems.
6) Harnessing shall conform to the details shown on the Drawings.

g. Product and Manufacturer: Provide one of the following:
1) Style 128, as manufactured by Dresser Industries.
2) Type 913, as manufactured by Smith-Blair.
3) Or Water Distribution approved equal.

B. Rubber Type Expansion Joints:
1. General:
a. Use rubber type expansion joints at all expansion joint locations, except where stainless steel expansion joints are shown on the Drawings or specified.
2. Liquid Service:
a. Expansion joints for liquid service shall be constructed of Neoprene or Buna N suitable for temperatures to 180°F.
b. Expansion joints shall be of the filled arch type. Furnish backup or retaining rings as recommended by the manufacturer.
c. Expansion joints shall be yoked in a manner to provide for transmission of any tension loading to which the joint may be subjected during system operation. The compressive and/or lateral movement of the joint shall not be impaired by the yoking system. Details of expansion joint yoking shall be submitted to the ENGINEER for approval.

D. Packed Expansion Joints:
1. The expansion joint shall be of the slip type containing injectable packing ports, allowing additional packing to be added under full line pressure.
2. Expansion joints shall be able to handle a 150 psi steam working pressure and to withstand 300°F temperature.
3. Graphite injectable packing and seals are required.
4. Internal and external guides are required and shall conform to ASTM SB 169-C614.
5. An approximate, 360-degree, stainless steel, extension limit stop shall be included on each slip tube. The slip tube shall be made from Schedule 80

carbon steel pipe, conforming to ASTM A 53 GR.B pipe through 16-inches internal pipe size (IPS).

6. The slip tube shall be hard-chrome plated 0.802-inch thick in accordance with ASTM B 650. The one piece body shall conform to ANSI A 53, GR.B.
7. A drain port shall be provided.
8. Flanges shall be ASTM A 105 raised face slip on or flat faced.
9. Internal and external non-chromed surfaces shall be coated with a 0.008-inch dry-film thickness of Tnemec Potapox epoxy coating.
10. Expansion joints minimum travel shall be 4-inches, and shall allow 0.5-inch expansion.
11. Expansion joints full stroke life cycle shall be a minimum of 20,000 full strokes.
12. Expansion joints shall have the same requirements as listed above.
13. Product and Manufacturer: Provide packed expansion joints of one of the following:
    a. Hyspan.
    b. Or equal.

F. Dielectric Connections:
1. Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions may be used instead of the specified insulating sections.
2. Product and Manufacturer: Provide one of the following:
    a. EPCO.
    b. Capitol Manufacturing.
    c. Or equal.

2.2 PAINTING

A. Clean and shop prime and shop finish coat ferrous metal surfaces of equipment in accordance with the requirements of Section 09 90 00, Painting.

B. Coat machined, polished and non-ferrous surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting shall conform to the requirements of Section 09 90 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping specialties and accessories in accordance with manufacturer's instructions and recommendations.

B. Make adjustments to expansion joints as required to ensure that they will be fully extended when the ambient temperature is at minimum operating temperature and

fully compressed at maximum operating temperature for the system in which they are installed.

+ + END OF SECTION + +

SECTION 40 06 70

PROCESS CONTROL SYSTEM INSTRUMENT INDEX

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish, install, calibrate, test, adjust, commission and place into satisfactory operation all primary sensors, field instruments and devices furnished.
   2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and devices and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

B. Coordination:
   1. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.
   2. Comply with the requirements of Section 40 61 13, Process Control System - General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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INSTRUMENT INDEX

Tag Number	P&ID	Serial Key #	Service Description	Spec. Inst. Type	Device	Size / Rating	Range	Setpoints	COMMENTS
LIT-100	I-04	TBD	WetWell Level	L1	Level Transmitter		0-16 Feet	LSL - 5 Feet (from wet well floor) LSH - 15 Feet (from wet well floor) LSHH - 16 Feet (from wet well floor) Start/Stop - TBD	wet well is total 23 feet deep
LIT-101	I-04	TBD	WetWell Level	L1	Level Transmitter		0-16 Feet	LSL - 5 Feet (from wet well floor) LSH - 15 Feet (from wet well floor) LSHH - 16 Feet (from wet well floor)	wet well is total 23 feet deep
PI-411	I-04	TBD	Lift Pump No.1 Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PSH-411	I-04	TBD	Lift Pump No.1 Discharge Pressure High	PS1	Pressure Switch		0-150 PSI		
PI-421	I-04	TBD	Lift Pump No.2 Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PSH-421	I-04	TBD	Lift Pump No.2 Discharge Pressure High	PS1	Pressure Switch		0-150 PSI		
PI-431	I-04	TBD	Lift Pump No.3 Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PSH-431	I-04	TBD	Lift Pump No.3 Discharge Pressure High	PS1	Pressure Switch		0-150 PSI		
PI-441	I-05	TBD	Lift Pump No.4 Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PSH-441	I-05	TBD	Lift Pump No.4 Discharge Pressure High	PS1	Pressure Switch		0-150 PSI		
PI-451	I-05	TBD	Lift Pump No.5 Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PSH-451	I-05	TBD	Lift Pump No.5 Discharge Pressure High	PS1	Pressure Switch		0-150 PSI		
PI-461	I-05	TBD	Lift Pump No.6 Discharge Pressure	P3	Pressure Guage	16"	0-150 PSI		
PSH-461	I-05	TBD	Lift Pump No.6 Discharge Pressure High	PS1	Pressure Switch		0-150 PSI		
FIT-500	I-05	TBD	Pump Station Discharge Flow	F1	Flow Transmitter	24"	0 - 16,000 GPM		
FIT-501	I-05	TBD	Pump Station Discharge Flow	F1	Flow Transmitter	24"	0 - 16,000 GPM		
PI-500	I-05	TBD	Pump Station Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PIT-500	I-05	TBD	Pump Station Discharge Pressure	P5	Pressure Transmitter		0-150 PSI		
PI-501	I-05	TBD	Pump Station Discharge Pressure	P3	Pressure Guage		0-150 PSI		
PIT-501	I-05	TBD	Pump Station Discharge Pressure	P5	Pressure Transmitter		0-150 PSI		
TT-001	I-06	TBD	LCP-PLC-LS40 Temperature	T1	Temperature Transmitter		o-150 F		
FS-007	I-08	TBD	Eyewash Flow	FS2	Flow Switch		TBD		
PSH-510	I-09	TBD	Biofilter Blower High Pressure	PS1	Pressure Switch		TBD		
DPSH-510	I-09	TBD	Biofilter Blower High Differential Pressure	PS2	Differential Pressure Switch		0 - 12 inches of water column		
DPSL-510	I-09	TBD	Biofilter Blower Low Differential Pressure	PS2	Differential Pressure Switch		TBD		

+ + END OF SECTION +

SECTION 40 10 15
FIBERGLASS REINFORCED PLASTIC DUCT AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Fiberglass reinforced plastic (FRP) ductwork and accessories for foul air systems.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements
3. Section 44 31 21.23 – Inorganic Biofilter

1.2 QUALITY ASSURANCE

1. Air Movement and Control Association (AMCA):
   a. 500-D, Laboratory Methods of Testing Dampers for Rating.
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME).
4. ASTM International (ASTM):
   a. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for high Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Temperature or High Pressure Service or Both.
   c. C582, Standard Specification for Contact- Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion- Resistant Equipment.
   d. D2310, Standard Classification for Machine-Made Fiberglass Pipe.
   e. D2563, Standard Pricing for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   f. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
   g. D3982, Standard Specification for Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting-Resin) Duct and Hoods.
   h. E84, Standard test Method for Surface Burning characteristics of Building Materials.
5. Sheet Metal and Air-Conditioning National Contractors Association (SMACNA):
   a. Thermoset FRP Duct Construction Manual.

B. Manufacturer’s Qualifications: Manufacturer shall have experience in manufacturing FRP duct of similar size and configuration to the duct specified herein. For a manufacturer to be determined acceptable for providing the FRP duct on this project, he must show evidence of a minimum of five installations and five years experience in the design and manufacturer of FRP duct of similar size and type as specified herein.

C. Provide, coordinate, service, and guarantee duct and duct accessories specified in this Section, from one supplier.

D. Except where shown in the Contract Documents, the manufacturer is responsible for locating flexible connections and expansion joints to accommodate installation and thermal expansion, respectively.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Raw material technical data sheets.
      c. All illustrations, detailed drawings, and instructions necessary for installing, operating, and maintenance repair.
      d. Ductwork pressure, vacuum, and temperature ratings.
      e. Structural design calculations for ductwork stamped and signed by a professional engineer.
      f. Flexible Connections and Expansion Joints: Expansion and contraction characteristics and limits.
      g. Dampers: Drawings showing connections and operator details.
   2. System Design:
      a. Blast gate and damper information including leakage data, performance data, and calculations showing ultimate strengths on blade and actuator to blade fastening.
      b. Fabricator's detailed structural calculations for fiberglass laminate design.
         1) Design for pressure, vacuum, expansion, wind, snow loading as well as deflection for support spacing shown on Drawings.
         2) Detailed structural calculations for wall thickness, stress and strain support reactions (including expansion/contraction forces) and expected loadings.
         3) The calculations will be reviewed by the Engineer for completeness for information only.
   3. Scaled installation Drawings for all the foul air duct system shown on the Drawings which shall include the following minimum information:
      a. Stationing.
      b. Elevations (centerline).
      c. Ductwork dimensions of subassemblies to be shipped.
      d. Duct and joint description.
      e. Location of dampers and fittings.
      f. Location of supports.
      g. Location of expansion and contraction joints.
      h. Details of duct supports including modifications (if any) to details shown on Drawings.

B. Samples of duct materials.

C. Manufacturer's Certificates as specified under Section 01 33 00.

D. Operations and maintenance manuals. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ductwork and Dampers:
      a. Belco Manufacturing Company, Inc.
      b. Daniel Company.
      c. Or equal.
   2. Flexible Connections and Expansion Joints:
      a. Mercer Rubber Co.
      b. Holz Rubber Co., Inc.
      c. Daniel Company.
      d. Or equal.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Temperature: 30 to 120 DegF.

B. Design Pressure Operating Conditions:

C. Design all duct to -20 to + 20 inches w.c. Fan will operate in that range.

D. Gases conveyed: Odorous Air.

E. Relative humidity: 30 to 100 percent.

F. Maximum velocity: 3,000 feet per minute.

G. Hydrogen sulfide: up to 20 ppm.

2.3 COMPONENTS

A. Duct:
   1. Designed and constructed in accordance with ASME/ANSE RTP1, latest revision.
   2. Filament-wound, conforming to the requirements of ASTM D 2310, Type 1, Grade 2, Class E.
   3. Contact molded reinforced laminate: Meet or exceed the requirements of ASTM C 582 and PS 15-69.
   4. Shop spool duct and fittings as much as possible.
   5. Minimize the use of flanges, with butt wrapped joints where required for installation.
   6. Use butt joints for shop welded joints only, unless approved by the Engineer.
   7. Ductwork shall have a flame spread rating of 25 or less.
   8. Resin:
      a. Use premium corrosion resistant vinyl ester resin: Hetron 922FR by Ashland Chemicals, Derakane 510A by Dow Chemical, or equal. Add up to 3 percent antimony trioxide for flame spread resistance.
      b. Liner Resin: Premium grade and corrosion resistant.
      c. UV Absorbers: Add UV absorbers to surfacing resin to improve weather resistance.
      d. Color: Use no dyes, pigments or colorants except in the exterior gel coat. White top coating.

e. Use no fillers or thixotropic agents unless specified.

9. Reinforcement and Laminate:
   a. Construction: Inner surface (corrosion barrier), an interior layer and an exterior layer.
   b. Inner Surface: Reinforce inner surface with a resin-rich surfacing veil, with a minimum 20 mils thickness. The inner surface shall be free of cracks and crazing with a smooth finish comparable to that achieved by the rotary contact molding method, with an average of not over two pits per square foot, providing the pits are less than 1/8-inch diameter and not over 1/32 IN deep. Pits shall be covered with sufficient resin to avid exposure of inner surface fabric.
   c. Interior Layer: Construct interior layer of resin reinforced with at least two plies of chopped strand mat with 25 percent glass and 75 percent resin content, total thickness at least 100 mils.
   d. Exterior Layer: the exterior layer or body of the laminate shall be of chemically resistant construction suitable for the service and providing additional strength necessary to meet the tensile and flexural requirements.
      1) For rectangular duct and transitions, apply chopped strand mat and woven roving layers in alternating order to form the composite construction of 70 percent resin by weight. Achieve a continuous layer by staggering and lapping layers. The exterior surface shall be relatively smooth and coated to insure no exposed fiber.
      2) For round duct, apply filament winding per ASTM D 2996 until the minimum wall thickness set forth by the design calculations and specifications is achieved. Apply one layer of woven roving after every 3/8 IN wall thickness of filament winding to allow for exotherming.
      3) Provide a shop applied resin gel coat of a color selected by the Engineer to the exterior of the duct.
      4) Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.
      5) Continuous roving used in chopper gun for spray-up: Type E glass.
      6) Continuous roving used for filament winding: Type E glass, with silane type finish.
10. Laminate Quality: Meet requirements of the visual acceptance criteria in ASTM D-2563, Level II for the interior and Level III for the exterior.
11. Wall thickness for rectangular duct shall be calculated using a safety factor of 5 to 1 for both vacuum and positive pressure per ASTM D3982. Wall thickness for round duct shall be calculated using a safety factor of 5 to 1 for vacuum pressure and 10 to 1 for positive pressure per ASTM D3982. Calculations shall be based on the structural fiberglass reinforced portion of the wall only.

B. Fasteners:
   1. Bolts for flanges: Type 316 L stainless steel, ASTM A 193, Grade B8M hex head bolts.
   2. Interior bolts for dampers: FRP bolts.
   3. Nuts: ASTM A 194, Type 316 L stainless steel, Grade 8M hex head nuts.
   4. Washers: ASME B18.22.1, Type 316 L stainless steel.

5. Fabricate bolts in accordance with ANSI B18.2.

C. Flanges and Fittings:
1. All fittings shall be of the same resin as and equal or superior in strength to the adjacent duct section, and shall have the same internal dimensions as the adjacent duct.
2. Construction: Spray-up/contact molding or mitered/hand lay up methods for fittings.
3. Thickness: Rated for specified pressure and vacuum, minimum thickness.
4. Bell and spigot joints shall be sealed with a standard butt joint overlay as per ASTM D3982. The interior opening between the bell and spigot joint shall be sealed with a resin paste so that no glass fibers are exposed and all voids are filled.
5. Total width of overlay for butt-wrap joints: 6 IN minimum for 6 to 30 IN duct; 10 IN minimum for 36 IN duct and larger.
6. Flanges shall be provided at dampers, expansion joints, equipment joints, bends, and fittings.
7. Flanges shall be drilled per ASTM D3982 Table 1 for all duct-to-duct connections and drilled to match for all equipment connections.
8. Full-faced, 1/8 IN thick, fabricated from ethylene propylene rubber (EPR) gaskets shall be provided at each flanged connection.
9. Flat washers shall be provided on all flange back faces.
10. Unless restricted by space constraints, bends shall have a minimum radius of 1.5 times the duct diameter. Under no circumstances shall bends have a radius less than 1.0 times the duct diameter.

D. Dampers:
1. Dampers shall be furnished for all odorous air duct as shown on the Drawings.
2. Material: FRP and of the same resin used for the ductwork.
3. Type: Butterfly.
4. Construction:
   a. Round, flange ends matching inside diameter of connecting ductwork.
   b. Single blade type complete with channel type frame.
   c. Full circumference blade seal.
   d. Angle type blade stop.
   e. Body material: FRP.
   f. Disc material: FRP.
   g. Shaft: Type 316 stainless steel.
   h. Shaft seal: EPDM or Teflon.
   i. Blade stop: FRP bar or angle.
   j. Blade seal: EPDM.
   k. Sleeve bearings: Molded Teflon.
5. Dampers shall carry the AMCA Certified Ratings Seal for air leakage and shall be tested as specified herein.
6. Leakage: 2 cfm/square foot at 30 IN w.g., maximum.
7. Damper headloss: 0.1 inches w.c. or less, when fully open, at 2,000 fpm.
8. Provide worm and gear operator, operating nut, and accessories, as necessary, for a complete operation.
   a. Provide electric operators as shown on the Drawings. Elsewhere, provide handwheels for manual operation.

b. Gear boxes shall be designed with a safety factor of at least 150% of required size to ensure gear box does not fail.

9. All dampers shall include a clean-out trip in order to ensure debris collected during processes does not interfere with blade to seal contact.
10. An 8 IN x 8 IN hatch to inspect the damper blade and seal shall be provided on all dampers greater than 24 IN in diameter.

E. Manual Operators:

1. Operator force shall not exceed 40 pounds under any operating condition, including initial breakaway. Gear reduction operator shall be used when force exceeds 40 pounds.
2. Operator shall be self-locking type or equipped with self-locking device.
3. Extension stems and/or chain wheels for dampers shall be provided so that the operators are reachable from the nearest service platform. Chains shall be type 316 L stainless steel.

F. Flexible Connections and Expansion Joints:

1. Flexible connections and expansion joints shall be furnished and installed as determined by the manufacturer and where indicated on the Drawings. Flexible connections shall be used in rigid FRP ducting systems for lateral, torsional, angular and axial movement due to expansion/contraction and vibration. Flexible connections may also be utilized for minimal ducting alignment.
2. Flexible connections and expansion joints shall be constructed of multiple layers of vulcanized polyester tire cord fabric reinforcement, sandwiched between 60-70 durometer EPDM elastomer inner liner and exterior cover. Tire cord fabric shall be layered at an optimal bias angle with Resorcinol Formaldehyde latex for superior rubber-to-fabric bonding.
3. 316 L stainless steel back up retainers and 316 L stainless steel nuts, bolts and washers shall be provided.
4. All hardware and materials shall be suitable for hydrogen sulfide laden corrosive atmospheres. All materials shall also be capable of resisting UV rays.
5. Built as one continuous piece with integral molded, hollow arched volutes permitting up to 4 inches of axial contraction and expansion.
6. Designed to allow for a minimum of 1 inch of offset movement in any direction.
7. Designed to withstand a maximum of 3 psi vacuum and 5 psi pressure.
8. Rated to withstand a maximum temperature of 220 DegF continuous service with 250 DegF intermittent spikes.
9. Flexible connections are to be provided for connections to fans or equipment. Supports shall be provided where necessary to avoid strain on the flexible connector.
10. Provide expansion joints where shown on the Drawings and where required to accommodate thermal expansion.
11. Provide flanges in accessible locations for removal of flexible connections and expansion joints.

2.4 ACCESSORIES

A. Extra Tappings:

1. Test port tappings shall be positioned as necessary for balancing. Manufacturer shall ensure tapping points are accessible for measurement.

B. Hangers and Supports:
1. All hangers and supports shall be manufactured from aluminum for corrosion resistance.
2. Provide saddles, guides, sleeves, sleeve liners, etc. as recommended by the Manufacturer.
3. Provide supports with spacing as shown on the Drawings. Where no supports are shown on the Drawings, design necessary supports to ensure maximum deflection of ½ percent of duct diameter or equivalent duct diameter for the service conditions above. Supports not shown on drawings shall be designed per structural design criteria provided on Contract Drawings.
4. All duct hangers shall be provided per SMACNA recommendations and manufacturers requirements. Hangers are to be securely fastened to avoid vibration and care shall be taken to install hangers so as to avoid creating conditions of stress in the finished installation.
5. Supports shall be designed to accommodate thermal expansion of the FRP ducts for a temperature range of 80 DegF through the use of sliding surfaces or location of expansion joints.

2.5 FABRICATION

A. Duct shall be supplied in the largest possible fabricated sections, allowing as few field joints as possible while assuring maximum quality control.
1. Manufacturer shall minimize the use of flanges with butt wrapped joints where required for installation.
2. Manufacturer shall shop spool duct and fittings as much as possible.

B. Reinforcing shall be factory installed with spacing between reinforcing located to avoid all hangers and support saddles.

2.6 SOURCE QUALITY CONTROL

A. Factory Inspection: Inspect fabrications for required construction, intended function, and conformance with referenced standards.

B. Inspection of products is required prior to shipment, unless specifically waived in writing by Engineer.

C. Notify Engineer one (1) week prior to estimated date of factory inspection.

D. Engineer has the option to test FRP duct materials and inspect the manufacturing facility at any time to assure compliance with specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct systems as shown on Drawings and in accordance with manufacturer's instructions.
1. The manufacturer shall have a qualified employee at the job site to instruct the Contractor's personnel in proper installation procedures for a minimum of two (2) days.

2. Instruction should include review of material safety data sheets as well as storage and handling of materials.
3. Install to the lines and grades shown on the Drawings.
4. Whenever duct laying is stopped, close open end of the duct with an end board closely fitting the end of the duct to keep foreign material out of the duct.

B. Field assembly joints must be completed in a neat and orderly manner, in compliance with manufactures instructions. Where safe and accessible all field joints 30 IN and larger shall have interior welds as specified in this Specification.All other cut duct ends or exposed glass fibers shall be resin coated prior to joint assembly to maintain corrosion resistance.

C. After laminate inspection has been completed, touch-up duct with field applied resin gel coat. Match color to factory applied gelcoat, using resin supplied from duct manufacturer. Obtain Engineer's approval for uniform quality of field and factory applied gel coats.

D. Connections to Existing Ductwork:
1. Cut existing duct at point of connection perpendicular to duct centerline.
2. Sand exposed opening level with plane of cut.
3. Thoroughly clean exposed duct of scale, debris and burrs, inside and out.
4. Fasten new duct to existing per manufacturer's instructions using adhesives and materials compatible with the resins in both the new and existing duct.

E. When the odorous air duct system is complete the duct manufacturer shall have a representative inspect the duct system and provide a written certification that it is installed properly and is ready for operation.

F. Out-of-roundness after installation should be limited to plus or minus 1 percent of duct inside diameter.

3.2 FIELD QUALITY CONTROL

A. Engineer has option to test FRP duct during construction to ensure compliance with the specifications.

B. Testing:
1. Prior to testing, pressurize system to 1.0 psi and survey all joints for audible leaks.
2. Repair/seal as necessary to seal all audible leaks.
3. After all audible leaks have been eliminated, test duct system at 0.75 psi pressure with air for 1 HR.
4. Pressure drop during test shall be less than 5 percent.
5. Contractor to repair all leaks and repeat test.
6. Determine leakage by loss of pressure.
7. Plug or cap branch lines as required during testing.
8. All testing shall be at the expense of the Contractor.

C. Identification:
1. Identify each shop fabricated duct section with a permanent marker on the inside near the ends.

D. Field Applied Resin:

1. After laminate inspection has been completed, touch-up duct with field applied resin gel coat. Match color to factory applied gel coat, using resin supplied from duct manufacturer. Obtain Engineer's approval for uniform quality of field and factory applied gel coats
2. Engineer has the option test FRP duct materials and inspect the manufacturing facility at any time to assure compliance with specifications

END OF SECTION

SECTION 40 46 16

PIPELINE TAPE COATING

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish all labor, tools, equipment and materials to prepare surfaces, apply, and test a prefabricated, cold-applied, multi-layer, pipeline tape coating system for steel pipe.

B. Except as described in this Section, the coating system shall be in accordance with ANSI/AWWA C214 for straight pipe sections and ANSI/AWWA C209 for fittings, specials, and field joints.

1.2 REFERENCE STANDARDS

A. Reference herein to “SSPC Specifications” or “SSPC” shall mean the published standards of the Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, PA 15213.

B. References herein to “NACE” shall mean the published standards of the National Association of Corrosion Engineers.

C. Steel Structures Painting Council (SSPC)

1.	SSPC-Vis 1	Pictorial Surface Preparation Standards for Painting Steel Structures
2.	SSPC-SP6	Commercial Blast Cleaning
3.	SSPC-SP10	Near White Blast Cleaning
4.	SSPC-PA2	Measurement of Dry Paint Thickness

D. National Sanitation Foundation (NSF)

1. Standard 61

E. Commercial Standards:

1.	ANSI/AWWA C200	Steel Water Pipe 6 inches and larger
2.	ANSI/AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
3.	ANSI/AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
4.	ASTM D1000	Methods of Testing Pressure-Sensitive Adhesive Coated Tapes Used for Electrical Insulation
5.	NACE RP-02-74	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

F. Federal Specifications:

1.	TT-P-28F	Paint, Aluminum, Heat Resisting (1200F)

1.3 SUBMITTALS

All submittals shall be per the requirements as specified in the Special and General Conditions.

A. Coating Materials List: Submit a list of the tape coating materials which indicates the manufacturer, product numbers, and thickness of the materials.

B. Materials Information: For each material, submit technical data sheets which itemize technical and performance information that indicates compliance with this Section.

C. Samples: Samples of the materials shall be submitted for testing by the Engineer. Each sample shall be clearly identified for catalog number, size, color, and other information required for testing.

1.4 QUALITY ASSURANCE

A. Provide the Engineer a minimum of 7 days advance notice of the start of any shop coating work and a minimum of 3 days advance notice for field work.

B. All such work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such work in its absence.

C. Inspection Devices: Furnish inspection devices that are calibrated and in good working condition for the detection of holidays and measurement of coating film thicknesses.

D. Inspection: Retain the services of trained technicians to test the coating system in the shop and field, and prepare reports. As a minimum, the tests shall include holiday detection and coating film thickness.

E. Tape application to straight pipe sections shall be monitored using instrumentation devices that continuously measure and record the tape width drawdown and the tape temperature. Each tap application station shall be equipped with the instrumentation devices. The tape tensions and temperatures shall be controlled using the data obtained from the instrumentation devices.

F. Manufacturer Representative:
   1. Require the tape material manufacturer to furnish a qualified factory technical representative to visit the pipe coating shop for technical support at the beginning of the tape coating operation and as may be necessary to resolve shop or field problems.

G. Holiday Detection: Prior to application of the first layer of mechanical protection tape, the inner layer tape shall be electrically tested for coating flows with a holiday detector approved by the Engineer. Holidays detected shall be immediately repaired and retested before application of the first layer of mechanical protection tape.

H. Immediately before the coated pipe is lowered into the trench, provide a visual and field electrical holiday inspection of the coating on the underside of the pipe.

PART 2 – PRODUCTS

2.1 COATING SYSTEMS

A. Suppliers listed below can usually supply the types of materials specified in this Section. Address given is that of the general office; contact these offices for information regarding the location of their representative nearest the project site:
   1. Factory and Field Tape Coating Systems:
      a. Polyken Technologies, Mansfield, MA, 02148.
      b. TapeCoat, Evanston, IL, 60240.
      c. Tek-Rap, Inc., Houston, TX, 77213.
   2. For clarity, specification references for individual tape products are only made for one manufacturer; other tape manufacturer's coating systems listed herein have similar acceptable coating products.
   3. Factory apply an 80 mils (minimum) thickness tape coating system to the exterior of pipe. Polyken YGIII Tape Coating System, Tapecoat P-TC50 Factory Coating System, Tek-Rap Series 250/255 In-Plant Coating System, or approved equal. Provide the coating system as detailed in the following paragraphs.

B. Provide straight pipe sections with a four-layer polyethylene tape system as described below.
   1. Storage primer.
   2. Primer layer.
   3. Filler tape, extruded butyl rubber compound compatible with the primer and tape.
   4. Weld stripping tape, if required (25 mils).
   5. Inner layer, corrosion protection tape (20 mils).
   6. Middle layer, mechanical protection tape (30 mils).
   7. Outer layer, mechanical protection tape (30 mils) with ultraviolet light stabilizers (Minimum 12 month protection).
   8. Total system thickness shall be at least 80 mils except as specified to be thicker at concrete anchor walls and vault walls.
   9. The coating materials shall be supplied by a single manufacturer, and shall have a successful application and service history on pipe.
   10. The coating system materials shall be as manufactured by Polyken Technologies, or approved equal, as itemized below:
      a. Storage Primer: 924.
      b. Primer: 1019.
      c. Pipe Coating Cutbacks: 924.
      d. Filler Tape/Mastic: 939.
      e. Weld Stripping Tape: 933-25 black.
      f. Inner Layer Tape: 989-20 black.
      g. Middle Layer Tape: 955-30 gray.
      h. Outer Layer Tape: 956-30 white.
      i. Storage Primer: 924.
      j. Minimum Total Thickness: 80 mils.
   11. Provide an additional (second) outer layer of tape through reinforced concrete anchor walls, vault walls, and reinforced concrete encasements.

Second layer of outer tape to be carried 12-inches beyond end of concrete.

C. Provide fittings and specials with a three-layer polyethylene tape system as described below:
   1. Storage Primer.
   2. Primer layer.
   3. Filler tape, extruded butyl rubber compound compatible with the primer and tape.
   4. Inner layer, corrosion protection tape (35mils).
   5. Outer layer, mechanical and ultraviolet light protection tape (35 mils).
   6. Total system thickness shall be at least 70 mils.
   7. The coating materials shall be supplied by the same manufacturer as the materials for straight pipe.
   8. The coating system materials for fittings and specials shall be as manufactured by Polyken Technologies, or equal, as itemized below:
      a. Storage Primer: 924.
      b. Primer: 1027.
      c. Filler Tape/Mastic: 939.
      d. Inner Layer Tape: 930-35 white.
      e. Outer Layer Tape: 930-35 white.
      f. Minimum Total Thickness: 70 mils.

D. Provide field joints with one of the following systems:
   1. Heat Shrinkable Sleeves:
      a. Primer: 1027.
      b. Mastic: 939.
      c. Heat Shrink Sleeve: 6000 Unishrink.
      d. Minimum Total Thickness: 90 mils.
   2. Cold Applied Tape per AWWA C209
      a. Primer: 1027.
      b. Mastic: 939.
      c. Tape: 932-50.
      d. Minimum Total Thickness: 100 mils.

E. Provide the following wrap system for the water pipeline in concrete encasements and where exposed in vaults, as follows:
   1. Straight Pipe Sections:
      a. Storage Primer: 924.
      b. Primer: 1019.
      c. Pipe Coating Cutbacks: 924.
      d. Filler Tape/Mastic: 939.
      e. Weld Stripping Tape: 933-25 black.
      f. Inner Layer Tape: 989-20 black.
      g. Middle Layer Tape: 955-30 gray.
      h. Two Outer Layers of Tape: 956-30 white.
      i. Minimum Total Thickness: 110 mils.
   2. Fittings and Specials:
      a. Storage Primer: 924.
      b. Primer: 1027.
      c. Filler Tape/Mastic: 939.

d. Inner Layer Tape: 930-35.
e. Middle Layer Tape: 955-30 gray.
f. Two Outer Layers of Tape: 930-35 white.
g. Minimum Total Thickness: 105 mils.

3. Field Joints:
   a. Heat Shrink Sleeves or Tape Wrap:
      1) Primer; 1027.
      2) Mastic: 939.
   b. Heat Shrink Sleeves, min total thickness: 180 mils.
   c. Tape Wrap, minimum total thickness: 140 mils

F. Storage of Materials: Materials shall be stored within the temperature ranges specified for application, using heated storage areas if necessary. Tape shall be stored at a temperature less than 120 degrees F.

PART 3 – EXECUTION

3.1 TAPE APPLICATION

A. Tape coating materials shall be applied in accordance with this Section, the product application instructions of the tape manufacturer, and the field technical support instructions from the manufacturer.

3.2 WELD SURFACE PREPARATION

A. To provide for an effective, long-term bond between the tape coating system and the substrate, the following pipe weld surface preparation shall be provided.
   1. All longitudinal and coil splice welds shall be ground to provide a smooth surface with a reinforcement not exceeding 1/32-inch., The resulting weld surface shall have a cross-section shape that is free is discontinuities, abrupt changes in curvature, with no ridges or valleys that may promote bridging or disbondment of the tape from the substrate. Special care shall be exercised so that grinding into parent metal does not occur.
   2. Weld Stripping Tape: Spiral weld height shall be limited to 1/8-inch or less in height, and a weld surface cross-section shape that is free of discontinuities, abrupt changes in curvature, with no ridges or valleys that may promote bridging or disbondment of the tape from the substrate. Weld stripping tape, 6-inches wide, shall be applied over all exterior spiral welds with the exception of approved hold back areas. The tape shall be applied with the center of the tape at the weld. Application of the weld stripping tape shall be such that the tape is completely pressed into the edge of the weld. The stripping tape application will be followed by a conformable roller applying sufficient pressure to achieve this requirement.

3.3 PIPE SURFACE PREPARATION

A. Prepare surface in conformance with current Steel Structures Painting Council (SSPC) Specifications as follows:
   1. Solvent Cleaning: SP 1.

2. Hand Tool Cleaning: SP 2.
3. Power Tool Cleaning: SP 3.
4. White Metal Blast Cleaning: SP 5.
5. Commercial Blast Cleaning: SP 6.
6. Brush-Off Blast Cleaning: SP 7.
7. Pickling: SP 8.
8. Near-White Blast Cleaning: SP 10.
9. Power Tool Cleaning to Bare Metal: SP 11.

B. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specifications refer to the applicable SSPC Specifications.

C. Follow OSHA and EPA regulations and coating manufacturer’s recommendations for surface preparation and coating application.

D. Hand tool clean areas that cannot be cleaned by power tool cleaning.

E. Surfaces to be coated shall be detergent cleaned in accordance with SSPC-SP1 prior to abrasive blasting.

F. All burrs, sharp edges, and weld splatter shall be removed prior to abrasive blasting.

G. Immediately before application of the primer, abrasive blasting shall be performed using sand, metallurgical slag, or a combination of steel grit and shot to produce a surface in conformance with SSPC-SP6. Steel grit shall comprise at least 60 percent of the working mix of abrasive, if a centrifugal wheel abrasive blaster is used. The prepared surface shall have a surface profile between 1-1/2 and 2 mils.

H. Abrasive blasting and primer application shall be done when the substrate surface is at least 5 degrees F above the dew point. Abrasive blasting, priming, and inner layer tape application shall be done during the same working day for each pipe section. Keep the pipe clean and dry. Remove all flash rust, imperfections, or contamination on cleaned pipe surface prior to application of primer.

I. Store primer at a temperature below 120 degrees F and apply only when temperature is above 50 degrees F minimum or per manufacturer’s requirements. Primer shall be protected from inclement weather, freezing or excessive thickening and shall be handled and stored per local, state and/or federal regulations.

J. Provide a uniform cured primer coat minimum of 0.5 to 1 MDFT, with no skips or misses, free of any runs, sags, and drips. Allow primer to dry to a dry-to-touch condition prior to application of tape layers. Keep primed pipe surface clean, free of any sand, grit, or other contamination. Repair areas of contamination, runs, and sags, and reprime skips and misses prior to application of tape coating.

3.4 PIPE END PREPARATION

A. Coating cut-backs at the pipe ends shall be 4 inches or that required to accommodate the specific joint or other considerations such as welding, with the cuts parallel to the pipe ends. Exposed substrate surfaces shall be protected with a storage primer applied immediately after taping and before flash rusting of the surface.

B. Spiral or longitudinal pipe welds within 18 inches of the pipe ends shall be ground flush prior to abrasive blast cleaning and coating.

C. Pipe ends that will be connected with sleeve-type couplings shall be epoxy coated with polyamide epoxy, Tnemec Series 139 Pota-Pox II or approved equal. The coating cut-backs shall be greater than 6 inches at couplings to provide clearance between the coupling and tape.

3.5 APPLICATION OF TAPE

A. Pipe shell temperature shall be maintained within a range of 45 degrees F to 100 degrees F during application of the tape system.

B. All tape rolls shall be maintained per manufacturer's requirements prior to application. Inner, middle and outer layer tapes shall be maintained at a minimum temperature of 90 degrees F during application.

C. Tape application tension shall be maintained at a value that produces a tape width reduction equal to 1.5 to 2.0 percent of the tape width during application, as recommended by the tape manufacturer. This width reduction shall be constantly maintained simultaneously with the minimum tape temperature.

D. At the point of tape application, all tape including weld stripping tape, shall be pressed onto the pipe with a pressure roller that maintains a constant pressure. Enough pressure shall be used to fully bond the tape at all welds.

E. Filler tape or mastic shall be used at lap joints, weld step-downs, and other discontinuities.

F. The tape application equipment and materials shall result in a fully bonded tape coating system, without blisters, voids, wrinkles or any areas that have a lack of bond to the pipe or previous layers of tape.

G. Succeeding layers of tape shall be applied so that the laps are staggered by at least two inches.

H. Electrically holiday test each section of pipe after application of the innerwrap with a holiday tester per the tape manufacturer's directions in accordance with national Association of Corrosion Engineers (NACE) Standard RP-02-74. Repair holidays (defects), if detected, before application of additional tape layers. Repair the holiday area by priming and applying a patch of repair tape. Cover with repair tape a minimum of 4 inches in all directions from damaged area. Retest the repaired area for holidays. Test holidays in middle and outerwrap layers in

accordance the tape manufacturer's directions. Make repairs in the Field Tape Coating Repair section of the specifications.

I. Inspect and test factory-applied tape coating system per AWWA specifications at pipe manufacturer. Coating systems shall adhere tightly to the pipe surface and the previous tape layers. Remove and replace tape layers with visual damage, wrinkles, voids, disbonded layers, surface contamination, or areas where holidays are detected at the factory.

J. Provide a monitoring system approved by the tape manufacturer that constantly records pipe and tape conditions during coating application. The minimum parameters to be recorded are pipe temperature, line speed, primer and tape roll body temperature, and tape tension, as well as a summary of holiday inspection testing.

3.6 FIELD TAPE COATING REPAIR

A. Conduct pipe surface preparation, primer application, and tape coating in a continuous operation and complete in the same time period. Store, handle, and apply tape and primer used for field coating of the tape-coated pipeline per AWWA C-209 and C-214, the tape manufacturer's directions, and these specifications.

B. Protect and store field tape and primer in a manner as recommended by the tape manufacturer, so as to maintain products above minimum and below maximum recommended temperatures. Do not store tape in stacks above 8 feet high. Store primer and tape in temperatures below 120 degrees F. Weather conditions and temperatures may require that primer and tape be stored in shade during summer and in a protected and heated location or box until time of application in winter. Apply primer above 50 degrees F. Apply tape above 70 degrees F.

C. Thoroughly mix primer prior to application and cover (seal) when not in use. Do not dilute primer.

D. Preheat the pipe when moisture collects on the pipe surface, the pipe temperature is below 40 degrees F, or the ambient temperature is below 10 degrees F to prepare the pipe surface for primer and tape application.

E. Shield (tent) the pipe and primed surfaces as required to provide protection from excessive rain, snow, moisture, dust, and contamination or temperatures that are too hot or too cold for good field coating operation.

F. Repair all areas where visual damage or holidays are detected. The number and thickness of the repair coating shall be the same as the number and thickness of the damaged factory coating layers. Repair tape system shall consist of field primer and 4- or 6-inch wide repair tape.

G. Remove damaged coating layers carefully with a sharp knife so as not to damage inner coating. Where outer layers are damaged, electrically holiday innerwrap, prior to repair of outerwrap. Provide one extra layer of repair tape to areas where coating damage to the base metal is detected.

H. Solvent Wipe: Solvent clean (SSPC-SP1) areas of oil and grease contamination with an approved solvent. Provide solvent type recommended by coating manufacturer. Extend solvent wipe onto intact coating a minimum of at least 6 to 8 inches past the joint, damaged coating, or contaminated area.

I. Thoroughly mix the primer prior to application. Apply primer after the damaged coating area is cleaned and dried. Extend primed area a minimum of 6 inches in all directions from the defective area. The minimum primer thickness shall be 1 to 2 MDFT when cured. Keep the primed area free of all contamination and allow to dry to dry-to touch condition before application of the repair tape.

J. Remove release liner just prior to application of the tape to the primed pipe surface. Remove the release liner completely from the tape; no release liner shall remain on the tape or pipe. Dispose of the release liner in an appropriate manner. Do not leave release liner, tape rolls, or other trash in the pipe ditch. Protect the adhesive surface of the tape to avoid moisture and contamination by foreign materials. Excessive contamination of the pipe or tape surface shall be cause for rejection of the field coating.

K. Apply repair tape of the same color as the shop applied tape to prime area and press firmly into place. Extend the repair tape a minimum of 4 inches in all directions onto undamaged coatings from the damaged area. If the damaged area is wider than the repair tape width, provide a minimum of 4-inch coverage in all directions by lapping the first tape layer with additional repair tape layers. Lap theses layers over the first layer, 1-inch minimum, as required to provide the minimum 4-inch coverage. Start the first layer at the bottom side of the pipe so that additional layers overlap top portion of first layer.

L. When sufficient coverage has been reached in the first layer of repair tape, apply a second layer of repair tape over the first layer in an opposite direction from the first layer to form a cross-hatch pattern. Extend the second layer a minimum of 4 inches in all directions from the damaged area. Provide the second layer a minimum of 1-inch overlap past the first repair tape layer. If holidays are detected in the first layer, repair and retest before the second layer is applied.

M. If a large area has been damaged, over 6 inches in size, apply the outer layer in a cigarette wrap around entire pipe circumference. Overlap cigarette wrap ends a minimum of 6 inches and point downward.

N. The completed tape repair shall adhere tightly to the factory coating and present a smooth unwrinkled appearance.

O. All field coating shall be applied, tested, and repaired by experienced personnel, so that the field coating system is equal to the original factory-coated system.

P. Repair all areas of visual tape damage. Repair or replace any visual areas of UV degradation of tape coating such as chalking, embrittlement, splits, or cracks in coating. Remove or replace tape with UV damage, wrinkles, voids, disbonded layers, surface contamination, visual damage, or areas where holidays are detected.

3.8 TAPE OR SLEEVE APPLICATION TO FITTINGS, SPECIALS, AND PIPE JOINTS

A. Filler tape shall be used to fill voids on fittings, specials, welds, and pipe joints.

B. All bell and spigot joints, lap joints, and other locations where voids will otherwise exist shall be provided specially shaped, filler tape applied after priming.

C. Field pipe joints shall be prepared as required by the paragraph entitled “Pipe Surface Preparation,” except that shop blasted surfaces that have been coated with a storage primer may be power tool cleaned instead of abrasive blast cleaned. The power tool cleaning shall be done in accordance with SSPC-SP2. Pipe ends not effectively protected with a storage primer shall be abrasive blasted to SSPC-SP6.

D. All tape or sleeve coated joints will be tested by the Owner with an electrical flaw detector capable of at least a 12,000 volt output, furnished by the Contractor. The tests shall be made using a voltage of 6,000 to 7,000 volts. Any holidays found shall be repaired by the Contractor.

3.9 ELECTRICAL COATING INSPECTION

A. Electrically test areas of damaged or questionable pipe coating, joint wrap, or pipe tape coating repairs with a portable high-voltage holiday detector. Test areas as directed by the Owner. Provide equipment and conduct testing in accordance with NACE Standard RP-02-74 and the coating manufacturer’s written directions for type and thickness of coating being tested. Furnish one portable high-voltage detector for each pipe laying crew.

B. Set electrical holiday test equipment at voltage as recommended by coating manufacturer. The minimum test voltage for a particular coating type and thickness shall be within 20 percent of the voltage as determined by the following formula:

$$\textit{Testing Voltage} = 1250\ T^{1/2}$$

Where T = Average coating thickness in mils (0.001 inch)

C. Provide the type of detector with the minimum and maximum voltage setting, inspection speed, and holiday detector electrode type (wire brush or electrically conductive silicone or coil spring) as recommended by the coating manufacturer for the coating type and thickness being tested. Maintain the holiday test equipment in good working condition per detector manufacturer’s recommendations.

D. Adjust the holiday detector during testing to the correct voltage setting and operate in accordance with holiday detector manufacturer recommendations. Recheck voltage setting at start of each day and a minimum of two times during day and when requested by Owner.

E. The holiday detector shall provide an audible signal when electrical contact is made between the pipeline and the electrode at holidays (defects) in the coating. Provide a good ground and a low electrical resistance between the holiday detector and the pipeline. Make only direct connections to uncoated areas or to the pipe ends at the pipe joint cut back areas.

F. The pipe surface shall be clean and dry when tested. To avoid damage to the coating, the electrode should always be kept in motion while test voltage is being applied. Always keep the electrode in firm contact with the coated surface. Move the electrode in an even manner over the surface at an approximate rate of 0.5 to 1 foot of travel per second. Do not exceed 1 foot of travel per second as the maximum rate of speed during holiday testing.

G. Mark location of detected holidays for repair. Retest after repair.

++END OF SECTION++

SECTION 40 61 13

PROCESS CONTROL SYSTEM – GENERAL REQUIREMENTS

1.1 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals as stated in the specified in the CONTRACT DOCUMENTS and install, calibrate, test, start-up, commission and place in satisfactory operation a complete Process Control System (PCS). PCS shall be as specified by Division 40, Process Interconnections Sections and all controls systems provided by others in all Divisions as specified on the CONTRACT DOCUMENTS.

B. The PCS is designed to control and monitor equipment operation and information. The unit processes, which the PCS shall control and monitor are shown and described in the CONTRACT DOCUMENTS.

C. EQUIPMENT SUPPLIERS are defined as suppliers or vendors who provide instrumentation, panels, equipment or services that interface with the PCS as specified in Division 40, Process Interconnections or other Divisions of the CONTRACT DOCUMENTS. EQUIPMENT SUPPLIERS shall coordinate with the PCS COORDINATOR (responsibilities as defined below).

D. OWNER shall configure all CCS (SCADA) software for the supplied CCS. However, CONTRACTOR shall be responsible for all hardware configurations, loop testing of signals, programming, and communications testing for new and modified existing control equipment (Including PLCs, OITs, etc.) through the CCS.All control loops shall function as described in Section 40 61 96, Process Control Descriptions or other Divisions and Drawings of the CONTRACT DOCUMENTS.

E. All instruments shall be field calibrated and witnessed by the ENGINEER as stated in Specification 40 70 00 Instrumentation for Process Systems.

1.2 QUALITY ASSURANCE

A. General:

1. The CONTRACTOR shall acquire the services of a PCS COORDINATOR for coordination of the furnishing, approval, installation, testing, commissioning, and training for all aspects of the PCS. The PCS COORDINATOR shall be the

CONTRACTOR's representative for all subcontractors providing PCS equipment.

2. CONTRACTOR in conjunction with the PCS COORDINATOR shall be responsible for coordination and supervision of the supply, storage, installation, testing, startup, commissioning and training of all electrical equipment, instrumentation, panels and services defined in the CONTRACT DOCUMENTS to produce a fully functional PCS.

3. CONTRACTOR in conjunction with the PCS COORDINATOR shall be responsible for proper operation of the PCS with related equipment and materials furnished by other suppliers stated in the CONTRACT DOCUMENTS.

B. PCS COORDINATOR's Qualifications:

1. Have experience at designing, supplying, installing, testing, start-up and commissioning PCS's.

2. Have experience in coordinating, reviewing and the handling of equipment submittals.

3. Have experience with integration, implementation and have supported standard lines of digital and analog processing control instrumentation equipment.

4. Have working knowledge in hardware application, data highway systems and computer control systems software programming procedures.

5. Have experience in coordinating or providing standard training course offerings in general process control applications and in operation, programming and maintenance of the control systems and related equipment.

6. Have a thorough working knowledge of waste treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.

7. Have thorough knowledge of relevant NEC, OSHA, MIL, NRC, ISA, SAMA, NFPA, UL and API standards and all relevant state and local codes.

8. Have experience in coordinating, reviewing, handling of and presenting equipment operations and maintenance training materials.

C. PCS COORDINATOR's Responsibilities:

1. General:

a. Attend the Pre-Construction Conference as required in Section 01 31 19.13– Preconstruction Meetings for the presentation of the responsibilities of the PCS COORDINATOR.

b. Coordinate with the CONTRACTOR in the generation of the Progress Schedule as required in Section 01 32 16.15– Construction Progress Schedule (CPM) to incorporate PCS construction activities into the Progress Schedule.

c. Attend the project Construction Progress Meetings required in Section 01 31 19.23– Progress Meetings.

d. Coordinate PCS Progress Meetings as described in Paragraph 1.3 below.

e. Maintain a punch list of items to be completed / corrected for the PCS. Provide an updated copy of this punch list to the ENGINEER at each construction progress meeting.

2. Reviews:

a. Review CONTRACT DOCUMENTS (Specifications, P&ID's, Process Drawings, Electrical Drawings, Installation Details, etc,) and develop a list of concerns or problems noted for the completion of the complete operating PCS. Submit list to the ENGINEER prior to review of equipment submittals.

b. Coordinate and review all PCS submittals and related equipment submittals in accordance with the CONTRACT DOCUMENTS, prior to submission of submittal to the ENGINEER. Complete Submittal Transmittal Form 01 33 23-A included in Section 01 33 10– Reference Forms for inclusion with each submittal.

3. Installation:

a. Verify delivery and proper storage of all PCS equipment per the requirements of Sections 01 65 00- Product Delivery Requirements. Complete 01 65 00-A - Equipment Delivery Inspection Report included in Section 01 33 10– Reference Forms for submittal to the ENGINEER.

b. Supervise the installation of the CCS instruments, panels, consoles, cabinets, wiring and other components required.

c. Coordinate with the CONTRACTOR in the development of all Maintenance of Plant Operations plans (MOPO's) affecting PCS equipment installation or activities as required in Section 01 14 16– Coordination With OWNER'S Operations.

d. Coordinate proper interfacing of CCS hardware, software, field devices and panels, including required interfacing with packaged control systems furnished by other equipment suppliers, and with the plant electrical system.

4. Testing:

   a. Coordinate all calibration, testing, start-up and commissioning of the PCS as outlined in the Contract Documents.

   b. PCS COORDINATOR shall submit to the ENGINEER a schedule with proposed start dates and test procedure guidelines for start-up, commissioning and field testing at least four weeks in advance of the test start date. Prior to testing each process area, coordinate with the CCS VENDOR to insure that the installation of the CCS software, including any modifications and software configuration testing is completed prior to testing each process area.

   c. Complete testing of each process loop through the CCS shall be documented by PCS COORDINATOR as listed in Section 40 61 93– Process Control System I/O list and submit the signed document to the ENGINEER upon successful completion of tests.

   d. Coordinate all testing documentation in accordance with Section 01 33 10, Reference Forms. Maintain a copy of Field Calibration Forms, Loop Test Forms, Equipment Test Reports, Loop Commissioning Forms, Factory Acceptance Test forms and other related forms from Section 01 33 10– Reference Forms in a single binder for submittal to the ENGINEER to be transmitted to the OWNER at the conclusion of the project.

   e. Attend all factory tests required by Division 01 Specifications and other Division Specifications of the CONTRACT DOCUMENTS that are inclusive of the overall PCS.

5. Commissioning and Substantial Completion:

   a. Coordinate and provide review comments of all PCS Vendor Equipment Operations and Maintenance Manuals (VEOMM) prior to submission of manual to the ENGINEER. Complete Submittal Review Form 01 78 23-B – Operations & Maintenance Data Review Checklist included in Section 01 33 10- Reference Forms for inclusion with each VEOMM submittal.

      1) Maintain a red-line of the VEOMM ‘s electrical drawings and schematics used during construction to reflect changes or deviations that occur during installation, start-up and commissioning for incorporation into the final VEOMMs. Submit the red-lined electrical

drawings and schematics to the provider of the equipment for updates as VEOMM Record Documents for submittal to the ENGINEER to be transmitted to the OWNER prior to Substantial Completion of the project.

b. Maintain red-line ISSUED FOR CONSTRUCTION DRAWINGS used during construction to reflect changes or deviations that occur during installation, start-up and commissioning for incorporation into the final Record Drawings. Submit the red-lined ISSUED FOR CONSTRUCTION DRAWINGS to the ENGINEER prior to Substantial Completion of the project.

c. Coordinate and supervise training of OWNER'S personnel in operation and maintenance of the process control system as required in Division 01 Specifications and other Divisions of the CONTRACT DOCUMENTS as per Section 01 79 00 - Instruction of Operations and Maintenance Personnel.

D. Reference Standards:

1. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in the CONTRACT DOCUMENTS.

a. ISA, The Instrumentation, Systems and Automation Society.

b. API, American Petroleum Institute.

c. UL, Underwriters' Laboratories, Inc.

d. AWWA, American Water Works Association.

e. Nuclear Regulatory Commission.

f. NEMA, National Electrical Manufacturers Association.

g. OSHA, Occupational Safety and Health Administration.

h. ANSI, American National Standards Institute.

i. MIL, Military Standards.

j. NFPA, National Fire Protection Association.

k. SAMA, Scientific Apparatus Manufacturers Association.

l. NFPA, National Fire Protection Association 79, Annex “D” Standards.

m. IEEE, Institute of Electrical and Electronic Engineers.

n. NEC, National Electrical Code.

o. FM, Factory Mutual.

1.3 COORDINATION AND PROGRESS MEETINGS

A. Schedule and coordinate the system installation with regard to all other Work on the site and in accordance with the provisions of the General Conditions. Said coordination shall be documented on the Project Schedule.

B. PCS coordination and progress meetings will be scheduled by the PCS COORDINATOR. The CONTRACTOR, ENGINEER, OWNER and appropriate EQUIPMENT SUPPLIERS shall be required to attend meetings during the time of active work on the PCS. A representative of the CCS VENDOR shall be required to attend meetings during the time of active work on the CCS. PCS COORDINATOR shall provide meeting minutes and updates to the project schedule.

1. The purpose of the meetings shall be to review the progress of the Work involving the PCS and provide coordination for installation, testing, commissioning, and training of the equipment to ensure that the Project Schedule is met.

2. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit CONTRACTOR to agreed procedures and schedules.

1.4 SUBMITTALS

A. Shop Drawings:

1. General:

a. Shop Drawing submittals are to be in accordance with the requirements of the CONTRACT DOCUMENTS and shall conform to the requirements of Section 01 33 00- Submittal Procedures and as required in other Division 01 Sections.

b. Manufacture or shipment of the PCS components shall not commence until related submittals have been reviewed by ENGINEER.

c. Shop Drawings shall be submitted in complete packages grouped to permit review of related items.

d. Review of Shop Drawings will be for conformance with CONTRACT DOCUMENTS and with regard to functions specified to be provided.

2. Submittal Requirements:

a. Product information for all PCS equipment. Include the following:

1) Manufacturer's product name and complete model number.

2) Equipment CMMS Tag and loop number as provided in Section 01 93 13.15 – Computerized Maintenance Management System Tags and from the CONTRACT DOCUMENTS.

3) Manufacturer's data sheets and catalog literature. Provide data sheets as shown in ISA-20-1981. For instruments not included in ISA-20, submit data sheets using a similar format.

4) Description of construction features.

5) Performance and operation data.

6) Installation and mounting details, instructions and recommendations.

7) Service requirements.

8) Dimensions.

9) List of recommended spare parts.

10) UL/UR Listing Numbers.

11) Electrical control schematics and field wiring diagrams

12) Ranges and set points of field and control panel instruments

b. Control Panel Information:

1) Control panels shall be furnished in accordance with the requirements as shown on the Drawings and as specified in Division 40, Sections 40 61 96 – Process Control Descriptions, 40 61 93 – Process Control System I/O List, 40 67 00 – Control Panels, 40 68 70– PLC's – Software and Programming and Division 26, Section 26 05 01– General Provisions

B. System Operation and Maintenance Manuals:

1. Furnish Operations and Maintenance Manuals for the PCS in accordance with Section 01 78 23, Operation and Maintenance Data.

C. Report Forms:

1. Four (4) copies of the Field Calibration Forms, Loop Test Forms, Equipment Test Reports, Loop Commissioning Forms, Factory Acceptance Test forms and other related forms from Section 00 60 00– Project Forms shall be submitted to the PCS COORDINATOR.

1.5 EQUIPMENT DELIVERY, HANDLING AND STORAGE

A. Comply with the requirements of Section 01 65 00, Product Delivery Requirements.

B. All arrangements for transportation, delivery and storage of the equipment and materials to be in accordance with the requirements of the CONTRACT DOCUMENTS and the requirements of equipment manufacturers.

C. PCS equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration or other damages. Clearly label contents of each container and provide information on the required storage conditions necessary for the equipment. Keep OWNER and ENGINEER informed of equipment delivery.

D. All equipment shall be handled and stored in accordance with manufacturer's instructions and relevant organization standards. Equipment shall be protected from weather, moisture and other conditions that could cause damage. Items that require a controlled environment for storage such as panels and microprocessor units shall be stored in a climate controlled warehouse or facility. EQUIPMENT SUPPLIER shall notify CONTRACTOR and PCS COORDINATOR, in writing, with copies to OWNER and ENGINEER of the storage requirements and recommendations for the equipment prior to shipment.

E. Provide shop as-built control panel drawings upon delivery of the control panel.

1.6 GENERAL REQUIREMENTS

A. Power Supplies:

1. All electrically powered equipment and devices shall be suitable for operation on 115-volt 60 Hz power. If a different voltage, a suitable transformer shall be provided if approved by ENGINEER and OWNER.

2. Appropriate power supplies shall be furnished by CONTRACTOR for all two wire transmitters, loops for monitoring discrete inputs and all necessary outputs.

3. Power supplies shall be mounted in enclosures and installed in the appropriate control room or field panel.

4. Design all power supplies for a minimum of 130 percent of the maximum simultaneous current draw.

B. Signal Requirements:

1. The control system shall be designed to use 4 to 20 mADC analog signals, unless otherwise specified.

2. Provide signal converters and repeaters, where required. In addition, analog inputs to the computer control system shall be through appropriate repeaters to provide signal isolation where series looped with other devices, and to allow the loop to maintain integrity even if the CCS is out of service. Power supplies shall be sized adequately for signal converter and repeater loads.

3. Signals shall be isolated from ground.

4. The system and associated input/output wiring will be used in a plant environment where there can be high energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

C. Miscellaneous:

1. All instrumentation and PCS components shall be heavy-duty types, designed for continuous service in a municipal waste treatment plant environment. The system shall contain products of a single manufacturer, where possible, and consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and be capable of field expansion

through the installation of plug-in circuit cards and additional cabinets as necessary.

2. Design all logic and control loops to fail-safe. Fail-safe is to protect system if a field wire becomes disconnected.

3. All field-mounted instruments and PCS components shall be designed for installation in humid and corrosive service conditions. All field mounted instrument enclosures and appurtenances shall conform to NEMA ratings listed in Division 26, Section 26 05 01–General Provisions.

4. Ranges and scales specified herein shall be coordinated to suit equipment actually furnished.

5. Field-mounted devices shall be protected from exposure to freezing temperatures and shaded from direct sunlight.

D. Environmental Conditions:

1. The control system shall be designed and constructed for continuous operation under the following temperature and humidity conditions:

a. Control Rooms:

1) Ambient Temperature: 60°F to 80°F normal range; 40°F to 105°F occasional maximum extremes.

2) Relative Humidity: 80 percent, normal; 95 percent maximum.

b. Indoor locations for digital processing equipment hardware, control panels and instruments:

1) Ambient Temperature: 40°F to 120°F.

2) Relative Humidity: 98 percent maximum.

c. Outdoor locations for instruments:

1) Ambient Temperature: -10°F to 131°F.

2) Relative Humidity: 100 percent maximum.

E. System Designs:

1. Range, scale and setpoint values specified in other Division 40, Process Interconnections Sections are for initial setting and configuration. Modifications to these values may be required based on actual equipment furnished and as

necessary to implement proper and stable process action and that is determined as systems are placed in operation. These modifications shall be done at no additional cost to OWNER.

2. For any items where ranges, scales and setpoints may not have been specified, CONTRACTOR shall submit a recommendation to ENGINEER for review.

1.7 SYSTEM START-UP, COMMISSIONING AND FIELD TESTING

A. Comply with the requirements of Section 01 75 16 – Equipment and System Startup and Performance Testing and include the additional requirements:

1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all equipment and coordinate all activities required to perform start-up, commissioning and field testing of the Process Control System. Field testing shall include an integrated system field test and operational availability demonstration.

2. Retain the services of the EQUIPMENT SUPPLIERS and CCS VENDOR to supervise and/or perform start-up, commissioning and field testing of all system components. As part of these services, the EQUIPMENT SUPPLIERS shall include for the equipment items not manufactured by the EQUIPMENT SUPPLIER, the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

B. System Check-Out and Start-Up

1. With the aid of the EQUIPMENT SUPPLIERS, responsibility belongs to CONTRACTOR to perform the following:

a. Check and approve the installation of all computer control system components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation. Check-out shall include the following items as a minimum:

1) All wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.

2) Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.

3) All control and monitoring loops shall be checked for signal continuity from source (such as field instrument/equipment, control panel, etc) to end destination.

b. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.

c. All instruments and devices shall be checked to verify compliance with the Specifications and approved Shop Drawings.

2. Provide all test equipment required to perform the testing and field calibration of instruments during system checkout and start-up.

3. Furnish to the ENGINEER certified calibration reports provided in Section 01 33 10, Reference Forms for field instruments and devices as soon as calibration is completed. Factory calibrations are not acceptable as a replacement for field calibrations. All instruments must be field calibrated and witnessed by the ENGINEER and OWNER.

a. Receipt of any calibration certificate shall in no way imply acceptance of the work or instrument.

b. Each calibration certificate shall be signed and dated by an authorized representative of CONTRACTOR. Three copies of each completed certificate shall be submitted to ENGINEER.

4. Furnish to the ENGINEER two copies of an installation inspection report 01 73 19 -A - Manufacturer's Installation Certification Form in Section 01 73 19 – Project Forms certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the EQUIPMENT SUPPLIER.

5. All spare parts must be on-site and accepted prior to commencing integrated system field tests.

C. Commissioning

1. Following the Process Control System checkout and initial operation, CONTRACTOR, with the aid of the EQUIPMENT SUPPLIERS and CCS VENDOR, perform a complete system test in the presence of the ENGINEER to

verify that all equipment is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational.

a. Commissioning can only begin when all instruments and control panels are installed and wired. Operation and Maintenance manuals and a schedule for training must be approved prior to Commissioning.

b. All spare parts must be on-site and accepted prior to Commissioning.

c. Submit to the ENGINEER a schedule for Commissioning, including a proposed start date and Commissioning test sheet examples at least three weeks in advance.

2. Commissioning shall exercise field signals between field equipment or instrumentation and each Input/Output Panel though the CCS's workstation graphic display. As a minimum, perform the following checks for each test:

a. All wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.

b. All instruments and devices shall be checked to verify compliance with the Specifications and approved Shop Drawings. The calibration of analog devices shall be verified including the zero and span.

c. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.

d. All analog loops shall be verified at each termination point at 0%, 25%, 50%, 75% and 100% signal levels.

3. Provide the following documentation for use during the Commissioning effort.

a. Complete panel schematic and internal point-to-point wiring interconnect drawings.

b. Complete electrical control schematics.

c. Complete panel layout drawings.

d. Complete field wiring diagrams.

e. Complete instrument loop diagrams.

f. Completed calibration certificates for all field and panel devices which require adjustment and/or calibration.

g. Provide one set of Commissioning documentation for the OWNER'S personnel, one set for the ENGINEER'S use, one set for field use, and the required number of sets for CONTRACTOR'S use.

4. The Drawings corrected and modified during Commissioning shall form the basis for the "As-Built" Record Drawing requirement as specified in this Section.

5. Any defects or problems found during the Commissioning effort shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.

D. Integrated System Field Test

1. Following the completion of Process Control System checkout and initial operation and CCS software testing the CONTRACTOR, with the aid of the EQUIPMENT SUPPLIER and CCS VENDOR, shall remain on-site and be available during this period to correct instrumentation and control system hardware problems. The integrated field test shall be performed to verify all equipment/instrumentation is operating properly as a fully integrated system with the CCS, and that the intended monitoring and control functions are fully implemented and operational.

2. Following software testing and demonstration of all system functions, the Process Control System including field sensors/transducers and instruments shall be running and fully operational for a continuous 48 hour period. The Operational Availability Demonstration specified below shall not begin until the continuous 48 hour integrated system test has been successfully completed and OWNER and ENGINEER agree that the Operation Availability Demonstration can begin.

3. Any defects or problems found with the instrumentation, control system hardware, control panel components/wiring and field devices during the integrated field testing effort shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.

1.8 PROCESS CONTROL SYSTEM TRAINING

A. Requirements and Responsibilities

1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER.

2. Retain the services of all PCS EQUIPMENT SUPPLIERS to provide operation and maintenance training for all Process Control System equipment as specified herein.

3. For equipment items not manufactured by the EQUIPMENT SUPPLIERS, the EQUIPMENT SUPPLIER shall provide for on-site training by an authorized representative of the equipment manufacturer as part of the Supplier's services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.

4. Responsibility for all costs associated with training both on-site and at the EQUIPMENT SUPPLIER'S facilities, including all required materials, texts and required supplies, belongs to CONTRACTOR.

5. All training shall be conducted in the normal eight hour working days until conclusion of the training course.

B. Submittals

1. Submit training plans conforming to the requirements of Section 01 79 00, Instruction of Operations and Maintenance Personnel. Included in the plan shall be course outlines and schedules for training to be provided at the EQUIPMENT SUPPLIER'S facilities.

C. On-Site Training

1. Training Covering the Control Equipment:

a. The EQUIPMENT SUPPLIERS shall provide thirty two (32) hours of operations training covering all system components.

b. Training course shall accomplish the following:

1) Provide all instructions required to operate and utilize all system components.

2) Provide all instruction required to monitor and control the system processes from the designated control panel.

3) Explain procedures for control of the system during scheduled or rescheduled shutdown and the subsequent start-up.

4) Provide instructions for routine preventative and troubleshooting maintenance.

2. CCS Training:

a. The CCS VENDOR shall provide thirty two (32) hours of training that covers the CCS as follows:

   1) Provide an overview of system hardware and software.

   2) It shall train people in configuration, operation and programming the CCS.

   3) The emphasis shall be placed on how to perform set point changes, minor programming changes, range changes, diagnostics and upkeep of documentation.

   4) Instruction for hardware and software maintenance, troubleshooting and maintenance planning.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this division shall require NSF/ANSI 61, Drinking Water System Components Health Effects, approval or comply with Arizona Administrative Code R18-4-213, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 40 61 93

PROCESS CONTROL SYSTEM INPUT I/O LIST

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. I/O lists are compiled as shown on the P&ID DRAWINGS. The I/O list is only the new I/O added under this Contract or requires loop testing due to modifications to the systems.

B. The form provided in this section, identifies the person(s) who witnessed all loop testing. The loop testing shall include the field device through to the computer control system. Once the loop is fully tested and complete, each witness will initial the appropriate space on the form.

C. Completed form to be transmitted to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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SECTION 40 61 93

PROCESS CONTROL SYSTEM INPUT I/O LIST

PART 1 - GENERAL

1.1 DESCRIPTION

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C. Completed form to be transmitted to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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SCADA PROCESS CONSTROL SYSTEM I/O LIST - COMPUTER CONTROL SYSTEM SPREADSHEET

CCS Programmer	Const. Admin	Contractor	I&C Inspector	P&ID Sheet No.	Device Loop #	Existing Point?	Service Description	Tag Extension	Serialized Key	Physical Address (Rack/Slot)	I/O Type	Communication Protocol	I/O Path				Counts - Low	Counts - High	Eng Units - Low (0%)	Eng Units - High (100%)	Eng Units	Alarm Setpoint	Alarm Priority	Archived Data					Comments
													Communication Line	Node Address	Point Address	Register Address								Archive	HARS Business	HARS Regulatory	Requester / Owner / Application	Archive Duration (<1mo/6mo/1yr/10y)	
				I-04	HMS-400	N	LP Runtime Reset	ResetDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-410	N	LP1 In Remote	RemoteDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	TAH-410	N	LP1 High Temp	HITempDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	GAH-410	N	LP1 Leak	LeakDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YA-410	N	LP1 VFD Fault	FaultDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	MN-410	N	LP1 Run Status	RunStatusDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YS-410	N	LP1 Disconnect	DscOpenedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	PSH-412	N	LP1 Discharge High Pressure	HighPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-420	N	LP2 In Remote	RemoteDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	TAH-420	N	LP2 High Temp	HITempDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	GAH-420	N	LP2 Leak	LeakDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YA-420	N	LP2 VFD Fault	FaultDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	MN-420	N	LP2 Run Status	RunStatusDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YS-420	N	LP2 Disconnect	DscOpenedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	PSH-422	N	LP1 Discharge High Pressure	HighPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-430	N	LP3 In Remote	RemoteDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	TAH-430	N	LP3 High Temp	HITempDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	GAH-430	N	LP3 Leak	LeakDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YA-430	N	LP3 VFD Fault	FaultDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	MN-430	N	LP3 Run Status	RunStatusDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YS-430	N	LP3 Disconnect	DscOpenedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	PSH-432	N	LP1 Discharge High Pressure	HighPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-103	N	Station Mode - PLC	RemDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-103	N	Station Mode - Local	LocalDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	LSL-100	N	Wetwell Low Level	LoLevelDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	LSH-100	N	Wetwell High Level	HiLevelDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	LIT-100	N	Wetwell Level Transmitter	EchoLossDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	LIT-101	N	Wetwell Level Transmitter	EchoLossDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	ZIC-413	N	LP1 Discharge Valve VLV-413 Closed	ClosedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	ZIO-413	N	LP1 Discharge Valve VLV-413 Open	OpenDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HY-413	N	LP1 Discharge Valve VLV-413 In Remote	RemoteDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YA-413	N	LP1 Discharge Valve VLV-413 Failed	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	ZIC-423	N	LP2 Discharge Valve VLV-423 Closed	ClosedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	ZIO-423	N	LP2 Discharge Valve VLV-423 Open	OpenDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HY-423	N	LP2 Discharge Valve VLV-423 In Remote	RemoteDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YA-423	N	LP2 Discharge Valve VLV-423 Failed	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	ZIC-433	N	LP3 Discharge Valve VLV-433 Closed	ClosedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	ZIO-433	N	LP3 Discharge Valve VLV-433 Open	OpenDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HY-433	N	LP3 Discharge Valve VLV-433 In Remote	RemoteDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	YA-433	N	LP3 Discharge Valve VLV-433 Failed	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HMS-400	N	LP Runtime Reset	ResetDO	TBD	TBD	DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-102	N	Wetwell Level Alarm Reset	ResetDO	TBD	TBD	DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-410	N	LP1 Run	RunDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-420	N	LP2 Run	RunDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-430	N	LP3 Run	RunDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-103C	N	LP1 Enable	EnableDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-103D	N	LP2 Enable	EnableDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HS-103E	N	LP3 Enable	EnableDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	SI-410	N	LP1 Speed Status	VFDSpeedAI	TBD	TBD	SOFT AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD	

SCADA PROCESS CONSTROL SYSTEM I/O LIST - COMPUTER CONTROL SYSTEM SPREADSHEET

				I-04	SI-420	N	LP2 Speed Status	VFDSpeedAI	TBD	TBD	SOFT AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	SI-430	N	LP3 Speed Status	VFDSpeedAI	TBD	TBD	SOFT AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	LI-100	N	Wetwell Level Transmitter	LevelAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	16	FT	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	LI-101	N	Wetwell Level Transmitter	LevelAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	16	FT	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HA-410A	N	LP1 Speed Control	VFDSpedCtrlAO	TBD	TBD	SOFT AO	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HA-420A	N	LP2 Speed Control	VFDSpedCtrlAO	TBD	TBD	SOFT AO	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	HA-430A	N	LP3 Speed Control	VFDSpedCtrlAO	TBD	TBD	SOFT AO	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04		N	LP1 Voltage Phase A to B	VAB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP1 Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP1 Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP1 Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP1 Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP1 Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP1 Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw								
				I-04		N	LP1 Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva								
				I-04		N	LP1 Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar								
				I-04		N	LP1 Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf								
				I-04		N	LP1 Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw								
				I-04		N	LP1 Peak Volt Amperes	PeakVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva								
				I-04		N	LP1 Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz								
				I-04		N	LP2 Voltage Phase A to B	VAB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP2 Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP2 Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP2 Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP2 Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP2 Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP2 Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw								
				I-04		N	LP2 Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva								
				I-04		N	LP2 Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar								
				I-04		N	LP2 Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf								
				I-04		N	LP2 Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw								
				I-04		N	LP2 Peak Volt Amperes	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva								
				I-04		N	LP2 Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz								
				I-04		N	LP3 Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP3 Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts								
				I-04		N	LP3 Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP3 Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP3 Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps								
				I-04		N	LP3 Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw								
				I-04		N	LP3 Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva								
				I-04		N	LP3 Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar								
				I-04		N	LP3 Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf								
				I-04		N	LP3 Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw								
				I-04		N	LP3 Peak Volt Amperes	PeakVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva								
				I-04		N	LP3 Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz								
				I-05	HS-440	N	LP4 In Remote	RemoteDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	TAH-440	N	LP4 High Temp	HITempDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	GAH-440	N	LP4 Leak	LeakDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	YA-440	N	LP4 VFD Fault	FaultDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	MN-440	N	LP4 Run Status	RunStatusDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	YS-440	N	LP4 Disconnect	DscOpenedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	PSH-442	N	LP4 Discharge High Pressure	HighPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	HS-450	N	LP5 In Remote	RemoteDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	TAH-450	N	LP5 High Temp	HITempDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	GAH-450	N	LP5 Leak	LeakDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	YA-450	N	LP5 VFD Fault	FaultDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	MN-450	N	LP5 Run Status	RunStatusDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	YS-450	N	LP5 Disconnect	DscOpenedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-04	PSH-452	N	LP5 Discharge High Pressure	HighPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	HS-460	N	LP6 In Remote	RemoteDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	TAH-460	N	LP6 High Temp	HITempDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	GAH-460	N	LP6 Leak	LeakDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	YA-460	N	LP6 VFD Fault	FaultDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	
				I-05	MN-460	N	LP6 Run Status	RunStatusDI	TBD	TBD	SOFT DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD	

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				I-05	YS-460	N	LP6 Disconnect	DscOpenedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-04	PSH-462	N	LP6 Discharge High Pressure	HighPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	ZIC-443	N	LP4 Discharge Valve VLV-443 Closed	ClosedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	ZIO-443	N	LP4 Discharge Valve VLV-443 Open	OpenDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HY-443	N	LP4 Discharge Valve VLV-443 In Remote	RemoteDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	YA-443	N	LP4 Discharge Valve VLV-443 Failed	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	ZIC-453	N	LP5 Discharge Valve VLV-453 Closed	ClosedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	ZIO-453	N	LP5 Discharge Valve VLV-453 Open	OpenDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HY-453	N	LP5 Discharge Valve VLV-453 In Remote	RemoteDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	YA-453	N	LP5 Discharge Valve VLV-453 Failed	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	ZIC-463	N	LP6 Discharge Valve VLV-463 Closed	ClosedDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	ZIO-463	N	LP6 Discharge Valve VLV-463 Open	OpenDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HY-463	N	LP6 Discharge Valve VLV-463 In Remote	RemoteDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	YA-463	N	LP6 Discharge Valve VLV-463 Failed	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	FQT-500	N	Discharge Flow Total	FlowTotalDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HS-440	N	LP4 Run	RunDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HS-450	N	LP5 Run	RunDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HS-460	N	LP6 Run	RunDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HS-103F	N	LP4 Enable	EnableDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HS-103G	N	LP5 Enable	EnableDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HS-103H	N	LP6 Enable	EnableDO	TBD	TBD	SOFT DO	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	SI-440	N	LP4 Speed Status	VFDSpeedAI	TBD	TBD	SOFT AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	SI-450	N	LP5 Speed Status	VFDSpeedAI	TBD	TBD	SOFT AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	SI-460	N	LP6 Speed Status	VFDSpeedAI	TBD	TBD	SOFT AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	FIT-500	N	Discharge Flow	FlowAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	#####	GPM	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	FIT-501	N	Discharge Flow	FlowAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	#####	GPM	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	PIT-500	N	Discharge Pressure	PressAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	150	PSI	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	PIT-501	N	Discharge Pressure	PressAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	150	PSI	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HA-440A	N	LP4 Speed Control	VFDSpedCtrlAO	TBD	TBD	SOFT AO	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HA-450A	N	LP5 Speed Control	VFDSpedCtrlAO	TBD	TBD	SOFT AO	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05	HA-460A	N	LP6 Speed Control	VFDSpedCtrlAO	TBD	TBD	SOFT AO	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	100	%	X	1	TBD	TBD	TBD	TBD	TBD		
				I-05		N	LP4 Voltage Phase A to B	VAB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP4 Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP4 Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP4 Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP4 Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP4 Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP4 Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw									
				I-05		N	LP4 Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva									
				I-05		N	LP4 Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar									
				I-05		N	LP4 Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf									
				I-05		N	LP4 Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw									
				I-05		N	LP4 Peak Volt Amperes	PeakVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva									
				I-05		N	LP4 Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz									
				I-05		N	LP5 Voltage Phase A to B	VAB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP5 Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP5 Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP5 Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP5 Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP5 Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP5 Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw									
				I-05		N	LP5 Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva									
				I-05		N	LP5 Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar									
				I-05		N	LP5 Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf									
				I-05		N	LP5 Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw									
				I-05		N	LP5 Peak Volt Amperes	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva									
				I-05		N	LP5 Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz									
				I-05		N	LP6 Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP6 Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts									
				I-05		N	LP6 Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP6 Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP6 Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	800	Amps									
				I-05		N	LP6 Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw									
				I-05		N	LP6 Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva									

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				I-05		N	LP6 Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar										
				I-05		N	LP6 Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf										
				I-05		N	LP6 Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw										
				I-05		N	LP6 Peak Volt Amperes	PeakVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva										
				I-05		N	LP6 Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz										
				I-06	JA-099	N	LCP-PCP-LS40 PWR Fail	PwrfailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	YA-099	N	LCP-PPC-LS40 UPS Fail	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	YA-001	N	LCP-PLC-LS40 UPS Fail	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	JA-001	N	LCP-PLC-LS40 PWR Fail	PwrfailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	YA-080	N	LCP-COM-LS40 UPS Fail	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	JA-080	N	LCP-COM-LS40 PWR Fail	PwrfailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	YA-097	N	GEN-LS40 Common Fault	FaultDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	YA-095	N	ATS-LS40-A SNDBY PWR	StandbyPwrDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	YA-096	N	ATS-LS40-B SNDBY PWR	StandbyPwrDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06		N	Instrument Air Compressor Running	RunStatusDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06		N	Instrument Air Compressor Fail	FailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	TT-099	N	LCP-PCP-LS40 Temp	TempAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	150	F	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06	TT-001	N	LCP-PLC-LS40 Temp	TempAI	TBD	TBD	AI	MOD	Phone Line	TBD	TBD	TBD	0	TBD	0	150	F	X	1	TBD	TBD	TBD	TBD	TBD				
				I-06		N	SES-LS40-A Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts										
				I-06		N	SES-LS40-A Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts										
				I-06		N	SES-LS40-A Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	4000	Amps										
				I-06		N	SES-LS40-A Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	4000	Amps										
				I-06		N	SES-LS40-A Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	4000	Amps										
				I-06		N	SES-LS40-A Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw										
				I-06		N	SES-LS40-A Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3400	kva										
				I-06		N	SES-LS40-A Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar										
				I-06		N	SES-LS40-A Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf										
				I-06		N	SES-LS40-A Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw										
				I-06		N	SES-LS40-A Peak Volt Amperes	PeakVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva										
				I-06		N	SES-LS40-A Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz										
				I-06		N	SES-LS40-B Voltage Phase B to C	VBC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts										
				I-06		N	SES-LS40-B Voltage Phase C to A	VCA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	480	Volts										
				I-06		N	SES-LS40-B Current Phase A	IA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	4000	Amps										
				I-06		N	SES-LS40-B Current Phase B	IB		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	4000	Amps										
				I-06		N	SES-LS40-B Current Phase C	IC		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	4000	Amps										
				I-06		N	SES-LS40-B Kilowatts	KW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw										
				I-06		N	SES-LS40-B Kilovolt Volt Amperes	KVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3400	kva										
				I-06		N	SES-LS40-B Kilovolt Amperes Reactive	KVAR		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	600	kvar										
				I-06		N	SES-LS40-B Power Factor	PFACT		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	1	pf										
				I-06		N	SES-LS40-B Peak Kilowats	PeakKW		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	3000	kw										
				I-06		N	SES-LS40-B Peak Volt Amperes	PeakVA		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	2500	kva										
				I-06		N	SES-LS40-B Frequency	Freq		TBD	SOFT AI	MOD	TP	TBD	TBD	TBD	TBD	TBD	0	60	hz										
				I-07	LSH-02	N	Ferrous Tank 1 High Level	HiLevel	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-07	LSH-04	N	Ferrous Tank 2 High Level	HiLevel	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-07	LSHH-02	N	Ferrous Tank 1 High High Level	HiLevel	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-07	LSHH-04	N	Ferrous Tank 2 High High Level	HiLevel	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-07	YA-1000	N	Ferrous Pump 1	Fault	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-07	YA-1100	N	Ferrous Pump 2	Fault	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-07	YA-1300	N	Ferrous Chloride	SysFault	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-08	FS-007	N	Eyewash Station Flow	FlowDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-09	JA-500	N	LCP-IBS-LS40	PwrfailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-09	JA-510	N	LCP-BOCB-LS40	PwrfailDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-09	MN-510	N	Blower Running	RunStatusDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-09	YA-510	N	Blower Fault Permissive	FaultDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				
				I-09	DPSH-511	N	Inlet Differential Pressure High	HiPressDI	TBD	TBD	DI	MOD	Phone Line	TBD	TBD	TBD	0	1	n/a	n/a	n/a	X	1	TBD	TBD	TBD	TBD	TBD				

SCADA PROCESS CONSTROL SYSTEM I/O LIST - COMPUTER CONTROL SYSTEM SPREADSHEET

DIGITAL INPUTS	68
DIGITAL OUTPUTS	2
ANALOG INPUTS	8
ANALOG OUTPUTS	0
TOTAL	78

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes all of the anticipated control strategies under this Contract. The required control strategies for the various unit operations is a combination of the representation shown in the CONTRACT DOCUMENTS and the requirements specified herein. The CONTRACT DOCUMENTS do not show all the required internal diagnostic indications. In addition to the signals shown in the CONTRACT DOCUMENTS, the following process control descriptions shall be provided, as a minimum:
   1. Analog Signals:
      a. Analog signals shall be 4 to 20 mADC unless otherwise stated.
      b. Analog signals that are connected to multiple devices in the loop shall be wired in series unless otherwise stated in the loop description.
      c. Loop power for all analog instruments shall be provided in the Local Control Panel (LCP) or Motor Control Panel (MCP). If there is no LCP or MCP, loop power shall be derived from the Computer Control System - Remote Input/Output Panels (RIO)
   2. Discrete Signals:
      a. Discrete signals for all field wires shall be designed to be fail safe.
         1) If a field wire for a control circuit device fails the equipment should be designed to shut down.
         2) If a field wire for an alarm circuit fails, the alarm shall be activated.
   3. Indication of a communications failure between any of the Programmable Logic Controllers (PLC) with the respective Computer Control System Field Control Unit (FCU) shall be programmed as an alarm in the Computer Control System. The broken communications link must be identified individually to assist in troubleshooting.
   4. Indication of a power failure at any of the PLC's and/or FCU panels shall be programmed as an alarm in the Computer Control System and identified individually to assist in troubleshooting.
   5. Mismatch alarms for all motorized equipment (e.g., pumps and gates, etc.). If the status feedback does not agree with the command after a time delay, annunciate the alarm in the Computer Control System.
   6. Runtimes shall be programmed in the Computer Control System for all pieces of equipment unless elapse Time meters are shown on the P&ID’s or listed in the loop descriptions.
   7. Digital and analog signals provided from Vendor supplied equipment that are not shown on the CONTRACT DOCUMENTS but are provided by the Vendor shall be verified and incorporated into the control systems.
B. The process control descriptions are written descriptions of the basic configuration and/or programming required to implement the sequential control of the unit processes shown in the CONTRACT DOCUMENTS and as specified. The control descriptions do not, in all cases, describe the process characteristics

fully. Finalizing and tuning of strategies, as required, by the process characteristics shall be accomplished during start-up.

C. OIT/SCADA/CCS programming shall include at a minimum, programming to match existing programming using the latest OWNER standards. The descriptions below contain basic equipment operation descriptions. Contractor shall coordinate with the OWNER to confirm all OIT monitoring, and control requirements are satisfactory.

PART 2 - PRODUCTS (NOT USED)

PART 3 - PART 3 - EXECUTION

3.1 Sewage Lift Station

A. Lift Station 40 operates solids handling submersible pumps in a wet well to pump raw wastewater to approximately 3.1 miles north to a discharge structure located at Guadalupe Road and I-10. The rehabilitated lift station will consist of 6 new lift pumps. Five lift pumps shall be operated under normal conditions as need in automatic mode of operation to maintain a system wetwell level setpoint. The sixth pump will be used as a backup when a pump is faulted or out of service. When the site PLC is not operational, a backup control panel will control the lift pumps based on wetwell level. A packaged ferrous chloride system is used for chemical injection. This system is monitored only by the site PLC. A biofilter system is used for odor control and is manually operated at the local control panels. The system is monitored only by the site PLC.

B. Sewage lift pumps:
   1. Local manual mode of operation: When the pump VFD is selected for local mode of operation at the MCP using the VFD keypad, the pump can be started, stopped, and speed controlled using the VFD keypad.
   2. Remote mode of operation: When the pump VFD is selected for remote mode of operation at the MCP using the VFD keypad, and the backup mode is selected for PLC control at LCP-BACKUP-LS40, the pump will be automatically started, stopped, and speed controlled by the PLC and OIT. When the level (LIT-101) in the wetwell rises above an operator adjustable system level setpoint and after a time delay, a pump will start and run and automatically speed adjust maintain the level setpoint. If the pump speed is at maximum and the level is below the system level setpoint for a time delay, a second pump will start and automatically speed adjust to maintain the system level setpoint. This process will continue as needed to maintain the system level setpoint. When the level is below the system level setpoint, and the pumps are running at minimum speed, after a time delay, a pump will stop. This process will continue as needed to maintain the system level setpoint but only five pumps can run at the same time. If the level in the wetwell reaches a low level condition as sensed by the level transmitters, the pumps shall not run until the level is no longer low. If the station mode is selected for local mode at LCP-BACKUP-LS40, the pumps shall not be controlled by the PLC but rather will be controlled by level transmitter LIT-100 as shown in the control schematics.

C. Ferrous Chloride System:
   1. The signals indicated in the contract documents shall be monitored and displayed. There are no control signals form the site PLC for this system.

D. Biofilter System:
   1. The signals indicated in the contract documents shall be monitored and displayed. If biofilter system is not able to operated, a PLC fail alarm shall be generated base on the alarm\fault signals indicated in the contract documents. There are no control signals form the site PLC for this system.

E. Flow Transmitters:
   1. The signals indicated in the contract documents shall be monitored and the flow total signals shall be used to totalize flow in the site PLC and used for display. Include individual pump flow rates and flow totals and combined flow. Flow total reset shall be programmed to reset totals in the PLC and at the pump control panel as shown in the drawings.

F. Pressure Transmitters:
   1. The signals indicated in the contract documents shall be monitored and displayed. High discharge pressure shall be created in the site PLC and shall be displayed for alarming. Reset shall be required.

G. Pressure Switches:
   1. The signals indicated in the contract documents shall be monitored and displayed. High discharge pressure shall be shall be displayed for alarming and used for pump insterlocking. Reset shall be required.

H. Level Switches:
   1. The signals indicated in the contract documents shall be monitored and displayed. Faults shall require reset.

I. Packaged Instrument Air Compressor System:
   1. The signals indicated in the contract documents shall be monitored and displayed.

J. Lift Pump Air Check Valves:
   1. The signals indicated in the contract documents shall be monitored and displayed.

+ + END OF SECTION + +

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SECTION 40 67 00

PROCESS CONTROL SYSTEM PANELS AND ENCLOSURES

PART 1 - GENERAL

1.1 SCOPE

A. Contract Documents illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, and accessories required for a completely integrated system.

B. Provide all labor, materials, equipment, documentation including drawings and incidentals as shown on the Drawings, specified and required to design, furnish, install, calibrate, test, start-up, program, configure, commission and place into satisfactory operation all panels, intermediate termination panels and/or enclosures including panel components and instruments.

C. Conform the design and construction of panels to the specifications herein.

1.2 COORDINATION

A. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

B. All control loops to function as described in Section 40 61 96, Computer Control System Process Control Descriptions and depicted on the CONTRACT DRAWINGS.

1.3 DEFINITIONS

A. **Intermediate Termination Panel (ITP)**: An Intermediate Termination Panel is any junction box that has terminals to terminate wires and no electrical or electronic powered devices. Exceptions are to be approved by the City of Phoenix (COP). These panels act as interim termination points for field wiring to be connected to the control systems equipment. Please note that junction boxes and pull boxes are different. ITP's are sometimes referred to as junction boxes. However, pull boxes are not allowed to have any wire splicing devices, including terminal blocks.

B. **Local Control Panel (LCP)**: A Local Control Panel is an industrial piece of equipment that contains electrical or electronic devices, in addition to wire terminals. Typically, it is a local panel connected to a specific piece of equipment to provide control and/or monitoring of that equipment. A local control panel contains voltages of 120VAC or below. Exceptions are to be approved by COP.

C. **Motor Control Panel (MCP)**: An Motor Control Panel is an industrial piece of equipment that houses components for the power distribution and starting of motors. The components may include motor starters and variable frequency drives.

1.4 QUALITY ASSURANCE

A. Reference Standards: Construction of panels and the installation and interconnection of all equipment and devices mounted within also comply with applicable provisions of the following, except where otherwise shown or specified.
   1. National Fire Protection Association 79
   2. National Electrical Code (NEC) current adoption.
   3. National Electrical Manufacturer's Association Standards (NEMA)
   4. American Society for Testing and Materials (ASTM)
   5. Operational Safety and Health Administration (OSHA) Regulations
   6. State and local code requirements
   7. Where any conflict arises between codes or standards, the more stringent requirement applies.
   8. All panel devices shall bear the label of the Underwriters' Laboratory (UL), Inc. or be UL Recognized. Some products certified by UL are components that are intended to be used in the manufacture of a complete listed product. These components cannot bear the UL symbol, but may use a special Recognized Component Mark.
      a. The UL/UR listed number shall be documented on the Bill of Materials on the drawings.
   9. The assembled LCP's and MCP's are to be conformed to meet UL 508A requirements and labeling.

B. Panel to be designed, schematics drawn and assembled by the manufacturer. Utilize one of the following Panel Manufacturers:
   1. RDC Electrical Corporation – (480) 874-1175.
   2. Industrial Power Solutions – (602) 466-9662.

1.5 SUBMITTALS

A. General:
   1. Reference Section 01 33 00 Submittals.
   2. Panels shall be furnished in accordance with the requirements as shown on the Drawings, and as specified in Division 26, Section 26 05 01 and Division 40 and 25, Sections 40 61 13, 40 61 96, 40 70 00, 40 06 70, 40 61 93 and 40 67 00.
   3. Generate drawing package utilizing AutoCAD versions 2004 through 2008. If utilizing a newer AutoCAD version, submit files saved at version 2008.
   4. Submit legible hard copies of the panel drawing package printed on 11" x 17" sheets and soft copies in both .dwg and .pdf format.
   5. Submit manufacturer's technical data sheets and product literature for the panel

and all components utilized. Cleary identify exact equipment and material that is being supplied on the manufacturer's data sheets.

6. Submit a sample nameplate with the submittal.
7. Identify general location of all conduit entry points on the Front Elevation drawing of the documentation package.
8. Submit calculations and recommended cooling and heating load requirements. Utilize the nVent Hoffman Cooling Selection tool at: https://coolingtool.nvent.com/index.html
9. Submit location and tube routing details for air conditioner drain line. Coordinate drain location with ENGINEER.

1.6 O&M Manuals

A. Comply with the requirements of Section 01 78 23, Operations and Maintenance Data.

B. Provide an electronic copy of the panel drawing package on a separate CD. Panel Drawings are to be provided electronically in AutoCAD version 2004 through 2008. If utilizing a newer AutoCAD version, submit files saved at version 2008.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 01 65 00, Transportation and Handling of Materials and Equipment.

B. Comply with the requirements of 01 66 00, Storage of Materials and Equipment.

C. Provide a laminated hard copy of the panel drawings, size 11" x 17", inside the panel upon delivery or project completion. If redline drawings are utilized, replace with approved laminated copies.

PART 2 - PRODUCTS

2.1 PANEL ENCLOSURES

A. General:
   1. Conform panels and enclosures to the NEMA requirements as stated in Specification 26 05 01, General Requirements.
   2. All outdoor panels shall be provided with sunshade structures or solar shields. Sunshade structures or solar shields shall be constructed as shown on CONTRACT DRAWINGS.
   3. Sizes shown on contract drawings are estimates. Furnish panels and enclosures sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring and other

components installed within.

4. Size the panel to provide 15% spare free space capacity.
5. Use stainless steel fasteners throughout.
6. Provide interior mounting panels and shelves constructed of minimum 12 gage steel.
7. Provide 12”x12” print pocket in panels with a 24” or larger door. Mount on inside door where no door mounted devices are located. If there is not enough room for a 12”x12” print pocket, provide a sized pocket to fit available room.
8. Provide enclosure mounting supports as required for floor, frame, or wall mounting. Indoor wall mount panels utilizing stainless steel unistrut. Outdoor wall mount panels utilizing PVC coated unistrut. PVC coated exceptions may be approved by COP for non-corrosive outdoor installs.

B. Construction Features:
   1. General Construction Features - Provide the following convenience accessories inside of each panel.
      a. One or more 120 VAC light fixtures with a minimum 40 watt lamp or LEDs with a snap switch for on/off control.
      b. Provide grounding studs or lugs for metal panels and doors.
      c. Provide all electrical components and devices, support hardware, fasteners, and interconnecting wiring required to make the panels and/or enclosures complete and operational.
      d. Provide oil resistant gasket completely around each door or opening.
      e. For panels located in the field or outdoors that have door mounted devices which do not meet the NEMA rating for the area, provide a window kit that includes a hinged door with a clear plastic window and an oil resistant gasket to encompass all non-NEMA rated panel instruments for this area.
      f. Provide full height doors.
      g. Provide panels with no extra holes or knockouts unless shown on CONTRACT DRAWINGS.

C. Environment
   1. General:
      a. Provide the following panel(s) with an air conditioner, heat exchanger or ventilation fan based on the submitted calculations for cooling and/or heating load requirements.
      b. Provide a heater for all panels located outdoors to maintain a minimum temperature of 68°F.
      c. Provide a separate supplementary protector for the cooling or heating equipment.
      d. Provide thermostats to automatically control heating and cooling requirements.
      e. Provide a high temperature switch, for alarm purposes, in all panels that require air conditioners, heat exchangers or ventilation fans. The contact

shall be wired to alarm to the Computer Control System.

1) Products and Manufacturers:
    a) Hoffman ATEMNC
    b) Or approved equal

2. Air Conditioner:
    a. Coordinate utilization of air conditioners with the ENGINEER.
    b. Provide an automatically controlled closed loop air conditioner with filtered and adjustable air louvers to maintain temperature inside each enclosure below the maximum operating temperature rating of the lowest rated component.
    c. Condensate Coltrols:
        1) For outdoor installations, provide a condensation drain line for each air conditioner.
        2) For indoor installations, provide an active condensate evaporation system.
    d. Coordinate space requirements for maintenance.
    e. Provide NEMA 4X for outdoor locations.
    f. Coat heating and cooling elements on ambient and enclosure sides including coils that are in contact with Plant's ambient environment with Heresite, or equal, for protection from hydrogen sulfide corrosion with hydrogen sulfide levels up to seven ppm.
        1) Coordinate application of coating with the ENGINEER.
    g. Provide integral heater to maintain internal temperatures above 40°F.
    h. Product and Manufacturer:
        1) Hoffman (McClean) G or N Series, Model Spectra Cool
3. Heat Exchanger:
    a. Coordinate utilization of heat exchangers with the ENGINEER.
    b. Provide an automatically controlled heat exchanger to maintain temperature inside each enclosure below the maximum operating temperature rating of the lowest rated component.
    c. Coordinate space requirements for maintenance.
    d. Products and Manufacturers:
        1) Hoffman
4. Ventilation Fan:
    a. Coordinate utilization of ventilation fans with the ENGINEER.
    b. Provide automatically controlled ventilation fans with filter to maintain temperature of indoor enclosures below the maximum operating temperature of the lowest rated component.
    c. Products and Manufacturers:
        1) Hoffman
        2) Or approved equal
5. Heater:
    a. If panel is not equipped with an air conditioner, provide adequately sized automatically controlled 120 VAC heater to maintain temperature inside

each enclosure above 40°F to a maximum of 80°F when the outside temperature is 0°F through 40°F.

b. Maintain a minimum four inch clearance or minimum clearance recommendations from the manufacturers from any device.

c. Product and Manufacturer:
   1) Hoffman
   2) Or approved equal

D. Identification:
   1. Provide laminated plastic nameplates with a white background and black lettering for identification of panels and components.
   2. Construct nameplates with 1/16” plastic and with beveled edges.
   3. Nameplate Mounting
      a. Indoor panels: Mount nameplates to the panel utilizing glue.
      b. Outdoor panels: Mount nameplates to the panel utilizing glue and with two self-sealing #4-40, round head, stainless steel screws.
      c. Glue Product and Manufacturer
         1) 3M – Nitrile High Performance Rubber & Gasket Adhesive – Part # EC-847
         2) Or approved equal
   4. Provide nameplates according to Table 2.1.C.5 and Section 3.1.B:

Nameplate Specifications			
Type	Size	Font	Font Size
Manufacturer Nameplate	*1½” x 6”	Arial	1/8“
Panel Nameplate	*2” x 7”	Arial	1/2“
Device Nameplate	*1½”x 2½”	Arial	3/16“

Table 2.1.C.5 Nameplate Specifications

This is a minimum height size requirement. Size nameplates large enough to display the information required to clearly identify the panel.

2.2 PANEL DEVICES:

A. General:
   1. Provide DIN rail mounted devices where practical.
   2. All devices mounted on the exterior of the panel shall match the NEMA rating of the panel.

B. Internal Component Labeling:

1. Provide a device label for devices mounted inside the panel that conforms to the criteria below:
   a. Instruments: Provide label with the instrument loop number as shown on the CONTRACT DRAWINGS. Place label below the instrument on the backplane.
   b. Supplementary Protector: Label each supplementary protector with CB and the number assigned in the supplementary protector schedule. Place label on the backplane.
   c. Fuses: Label each fuse with FU and the number assigned in the fuse schedule. Place a label on the backplane that includes the fuse number and the fuse size.
   d. Control Relays: Label each relay with CR and the number assigned in the panel drawings. Place label below the relay on the backplane.
   e. Terminal Strips: Label each terminal strip with the terminal strip type. (ex. TB1, TB2, ATB). Place label above the terminal block or at first terminal on the backplane.
   f. Door Mounted Devices: Provide a label on the interior of the front panel door for every panel device. The label should contain the same information as shown on the front panel nameplate. Place the label below the device.
   g. Wireway Covers: Label wireways with the voltage that is being routed through it. For example; “24 VDC” for DC voltage or “120VAC” for AC voltage. Place label on wireway cover. Coordinate label size to fit on wireway cover.
   h. Identify internal components with permanent adhesive plastic labels.
      1) Product and Manufacturer:
         a) Brady USA Inc.
         b) Or approved equal
      2) Provide device label size and fonts per Table 2.2.B.1:

Device	Label Size	Font Size	# Points	Brady Part #
(Wireways) 24VDC	1”x 4”	Arial	48 Points	PTL-42-422
(Wireways) 120VAC	1”x 4”	Arial	48 Points	PTL-42-422
Misc. Device Labels	1”x 1”	Arial	16 Points	PTL-19-423
Panel Door Devices	1” x 1.5”	Arial	8 Points	PTL-31-423

Table 2.2.B.1 Panel Interior Device Label

C. DIN Rail
   1. General: DIN rail is the metal rail used to mount various electrical components in a panel
   2. Mount all internal components on DIN Rail
   3. DIN Rail for terminal blocks shall be raised DIN rail to match the height of the

wireways.

4. Product and Manufacturer, Provide one of the following:
   a. Phoenix Contact
   b. Or approved equal

D. Control Circuit – Supplementary Protectors:
   1. Provide single pole supplementary circuit protectors with the following features, 120 Volt AC, DIN rail mounted and UL 1077 listed with auxiliary contacts.
   2. Provide end caps, marking strips, insulated side jumpers and other accessories.
   3. Product and Manufacturer, Provide one of the following models where “xx” is the appropriate rating.
      a. Phoenix Contact, TMC 1-M1-xxA
      b. Allen-Bradley, 1492-SP1Bxxx
      c. Idec, NC1V-XXXXX-XXAA

E. Air Conditioner or Heater Supplementary Protectors:
   1. Provide supplementary protectors with the following features, 120 Volt AC, DIN rail mounted and UL 489 listed with auxiliary contacts.
   2. Product and Manufacturer, Provide one of the following:
      a. Allen-Bradley, Bulletin 1489
      b. Or approved equal

F. Control Relays:
   1. Type: General purpose, plug-in type rated for continuous duty.
   2. Construction Features:
      a. Coil Voltages: 120 VAC
      b. Contacts:
         1) Silver cadmium oxide rated not less than ten amperes resistive at 120 VAC or 28 VDC continuous.
         2) For switching low energy circuits (less than 200 ma) fine silver, gold flashed contacts rated not less than three amperes resistive at 120 VAC or 28 VDC continuous shall be provided.
         3) Number of contacts:
            a) Minimum: Two double pole/double throw contact sets
            b) Maximum: Four double pole/double throw contact sets.
      c. Relays shall have a clear plastic dust cover.
      d. Socket type to be blade.
      e. Remotes and Lift Stations shall have LED indicator; all other relays are not required to have LED indicators.
   3. Product and Manufacturer: Provide one of the following:
      a. Square D Company, Type R and/or Type K.
      b. IDEC, Type RH and/or Type RY.
      c. Potter & Brumfield.

d. Or approved equal.

G. Time Delay Relay:
1. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break one shots or interval operation.
2. Construction Features:
a. MOS digital circuit with transformer coupled power.
b. Switch selectable ranges
c. Minimum Setting: Three percent of range; except 50 ms for one second range.
d. Contacts:
1) Type: DPDT.
2) Rating: Seven amps resistive at 120 VAC, seven amps at 24 VDC.
e. Housing:
1) Plug-in design with dust and moisture resistant molded plastic case.
f. Power Input: 120 VAC
3. Product and Manufacturer: Provide one of the following:
a. Automatic Timing and Controls Company.
b. IDEC.
c. Or approved equal

H. Selector Switches, Pushbuttons and Indicating Lights:
1. General:
a. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
b. Type: Heavy duty, oil tight
c. Mounting: Flush mounted on panel front, unless otherwise noted.
d. NEMA rated to match panel in which mounted.
2. Selector Switches:
a. Type: Provide selector switches with number of positions as required to perform intended functions as shown on the Drawings and specified.
b. Contacts:
1) Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
2) Type: Double break, silver contacts with movable contact blade providing scrubbing action.
3) Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than ten amperes resistive at 120 volts AC or DC continuous.
c. Switch Operator: Standard black knob.
3. Pushbuttons (Standard or Illuminated):
a. Momentary Type: Provide momentary, booted type pushbuttons as required to perform intended functions specified and shown on the

Drawings. Boot color to be red for stop buttons and black for other functions.

b. Maintained Type: Provide maintained, push/pull, “Mushroom” type, red in color, to perform intended functions as specified, and as shown on the drawings.
   1) Emergency Stop button shall be red and the base of the button shall be yellow.

c. Contacts: Comply with the requirements specified for selector switches.

4. Indicating Lights:
   a. Type: Compact, integral non-transformer type.
   b. Lamps: 120 VAC, long life (20,000 hours minimum).
   c. Common, push-to-test circuitry shall be provided for each panel to simultaneously test all indicating lights on the panel using a single pushbutton.
   d. Button and Lens Colors:
      1) Red for indication of open, on, or running.
      2) Green for indication of closed, off (ready), or stopped.
      3) Amber for indication of equipment malfunction, process trouble or alarms.
      4) White for indication of electrical control power on.
5. Rotary Cam Switches:
   a. Provide rotary cam switches with number of positions and poles as required performing the signal switching function specified and shown on the Drawings.
   b. Contacts:
      1) Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required performing intended function.
      2) Contact Rating: Compatible with AC or DC through-put current of signals and devices simultaneously operated by the switch contacts, but not less than 20 amperes at 600 VAC or 250 VDC continuous.
   c. Switch Operator: Standard black knob.
6. Product and Manufacturer: Provide one of the following:
   a. Square D.
   b. General Electric.
   c. Allen-Bradley Co.
   d. Or approved equal

I. Potentiometer:
   1. Type: Industrial potentiometer operator, direct acting, 3/4 to full turn; and standard 3-wire potentiometer.
   2. Required Features:
      a. NEMA rated to match panel in which mounted.
      b. Resistance Range: 0 to 10,000 Ohms.
      c. Resistance Element: Wire wound or conductive plastic.

d. Power Rating: Two watts.
e. Mounting: Flush mounted on panel front, unless otherwise noted.
f. Provide legend plate for indication of position (0 to 100 percent).

3. Product and Manufacturer: Provide one of the following:
   a. Square D.
   b. General Electric.
   c. Allen-Bradley Co.

J. Power Supplies:
1. General
   a. Panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown on the Contract Drawings.
   b. Panels shall be provided with an internal 120 VAC with number of circuits and separate supplementary protectors sized as required to distribute power to the panel components.
2. Power Supplies/Switches.
   a. General:
      1) Din Rail Mountable
      2) Input Voltage 12VDC, 24VDC, 120 VAC
      3) Setting Range of Output Voltage 5 VDC…15VDC, 24VDC
      4) Products and Manufacturer: Provide the following by Phoenix Contact:
         a) DC/DC Converters Mini-PS-12-24DC/5-15DC/2 - Part # 2320018 (only if needed).
         b) Power Supply Unit – Quint-PS/1AC/24DC/5 – Part #2866750
         c) Uninterruptible Power Supply – Quint-UPS/24DC/24DC/10 – Part # 2320225
         d) Industrial Ethernet Switch – Cisco router with SEC bundle w/SEC license - CISCO ISR4321-SEC/K9

K. Wire:
1. General
   a. Provide internal wiring of Type MTW stranded copper wire with thermo-plastic insulation with no nylon jacket rated for 600 V at 90°C for single conductors.
   b. No utilization of Type THHN for panel wiring.
   c. For DC panel signal wiring, use #16 AWG shielded minimum.
   d. For AC power wiring, use #14 AWG minimum. For AC signal and control wiring, use #16 AWG minimum. For wiring carrying more than 15 amps, use sizes required by NEC and NFPA 79 Standards.
   e. Identify wires at each end using heat shrink labels with permanent number codes using a Brady LS2000 Labeling System, or approved equal.
   f. Panels conform to the wire color code as shown in Table 2.2.K.1.f Wire Color Code and NFPD 79 Standards.
2. Product and Manufacturer: Provide one of the following:

a. Carol
b. Belden
c. Anixter

WIRE COLOR CODE TABLE (Inside Panels)			
TYPE	FUNCTION	INSULATION COLOR	WIRE SIZE
AC POWER - HOT	120VAC	**BLACK	#14
AC POWER - NEUTRAL	120VAC	WHITE	#14
AC GROUND	120VAC	GREEN	#14
AC CONTROL	120VAC	**RED	#16
ISOLATED DC GROUND	GROUND	GREEN W/YELLOW	#16
DC POWER	SOURCE	BLUE	#16
DC POWER	COMMON	WHITE /BLUE	#16
CONTROL	FOREIGN VOLTAGES	ORANGE	#16
LOW VOLTAGE AC	24 VAC SOURCE	BROWN	#16
LOW VOLTAGE AC	24 VAC COMMON	BROWN W/WHITE	#16
*AC POWER	480 VAC PHASE A	BROWN	Size to FLA
*AC POWER	480 VAC PHASE B	ORANGE	Size to FLA
*AC POWER	480 VAC PHASE C	YELLOW	Size to FLA
TEMPORARY	TEMPORARY	PURPLE	Size to FLA

Table 2.2.K.1.f Wire Color Code

*** - For Motor Control Panels (MCP's) that are permitted to contain 480 VAC**

**** - Black 120 VAC wires are hot unless powered down via supplementary circuit protector. Red 120 VAC wires are hot based on the control logic state.**

L. Single Shielded Pair Cable:
1. Tinned copper, nineteen strand, PVC insulated conductors, No. 16 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 16 AWG copper drain wire and PVC black or gray outer jacket. Wire conductor colors

shall be black (-neg) and red (+pos). 600 Volt Tray Cable (TC) rated.

2. Product and Manufacturer: Provide one of the following:
   a. Belden Company (No. 9342).
   b. Okonite Company.
   c. Dekoron Wire and Cable Company.
   d. Or approved equal.

M. Wire Terminations:
1. Terminate all field and internal component wiring using insulated ferruled connectors attached with manufacturer's recommended tool.
2. Excessive stripping of the wire so as to allow bare wire outside the insulated ferrule is not permitted.
3. Utilize insulated double ferruled connectors wherever two wires terminate on the same terminal block connection.
4. Product and Manufacturer: Provide one of the following:
   a. Phoenix Contact – Clipline
   b. Thomas & Betts
   c. Weidmuller

N. Terminal Blocks:
1. General
   a. Numerically code terminals utilizing terminal block manufacturer's marking system. Information must be printed directly on the terminal label. Sticky back labels are not permitted.
   b. Terminal blocks must be DIN rail mountable with screw clamp connections. Spring cage connections are not permitted.
   c. Double level terminal blocks are permitted for use with signals on ATB only.
   d. Terminals used for analog signals on ATB shall be colored blue.
   e. Terminal block jumpers must be connected via screw clamp. Screw clamped comb jumpers are permitted. Plug in jumpers are not permitted.
2. Product and Manufacturer: For each terminal strip type provide one of the following:
   a. Power Terminal Block (PTB)
      1) Phoenix Contact, Type UK 5 N, Color Gray, Model # 30 04 36 2
      2) Allen Bradley, Type 1492-J4, Color Gray, Model # 1492-J4
      3) Weidmuller, Type WSU 4, Color Dark Beige, Model # 1020100000
   b. Field Wiring Discrete Signal Terminal Blocks (TB1 and TB2)
      1) Phoenix Contact, Type UDK 3, Double Connection, Color Gray, Model # 27 75 37 5
      2) Weidmuller, Type WDU 4/ZZ, Double Connection, Double Level, Internal Connection, Color Dark Beige, Model # 1905060000
   c. Field Wiring Analog or Internal Wiring DC Power (ATB) - Single Level Terminal Blocks:

1) Phoenix Contact, Type UK 3N BU, Color Blue, Model # 30 01 51 4
2) Allen Bradley, Type 1492-J3-B, Color Blue, Model # 1492-J3-B
3) Weidmuller, Type WDU 2.5 BL, Color Blue, Model # 1020080000

d. Field Wiring Analog or Internal Wiring DC Power (ATB) - Double Level Terminal Blocks. Alternating double and single level ATB terminal blocks are permitted.
1) Phoenix Contact, Type MBKKB 2,5 BU, Double Level, Color Blue, Model # 27 71 09 4
2) Allen Bradley, Type 1492-JD3-B, Double Level, Color Blue, Model # 1492-JD3-B
3) Weidmuller, Type WDK 2.5 BL, Double Level, Color Blue, Model # 1021580000

O. Surge Protection:
1. Provide DC surge protection with integrated varistor for all analog signal loops that are terminated to Programmable Logic Controllers provided in accordance with Specification Section 40 68 70, Programmable Logic Controller, Software and Programming.
2. Provide maintenance free, self-restoring surge protection to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. Device shall be removable without interrupting the circuit
3. Provide a separate surge protector for the positive and a separate surge protector for the negative polarity of each loop.
4. Mount the surge protectors on the ATB.
5. Ground the surge protectors to the panel DC ground bus.
6. Label the surge protectors in sequential order starting with the ATB signals.
7. Required Features:
a. Amp Rating: Compatible with working voltage and current of device being protected.
b. Voltage Rating: Compatible with the working voltage of protected device.
c. Reaction Time: nanosecond range
8. Product and Manufacturer: Provide one of the following:
a. Phoenix Contact
b. Advanced protection Technologies
c. EDCO
d. Or approved equal

P. Wireways:
1. General:
a. Mount wireways using stainless steel bolts. Drill and tap the sub-panel to accommodate the bolts.
b. Color to be Gray or White throughout the entire panel. Provide only one color.
c. All wireways to include cover.

d. Wireway covers to be labeled as per section 2.2.B

2. Product and Manufacturer: Provide one of the following:
   a. Panduit
   b. Thomas & Betts
   c. Or approved equal

Q. Motor Starters and Overload Relays:
   1. Refer to Specification Section 26 18 49, Combination Motor Starters

PART 3 - EXECUTION

3.1 EXTERIOR PANEL

A. Component Layout:
   1. Arrange associated control and indication devices for a particular part of the process in close proximity to each other.
   2. Mount indicating lights above control switches and push buttons.
   3. Standard component spacing is 3 ½" center to center and 3 ½" above and below. It is acceptable to use more space if required, but spatial consistency must be maintained.
   4. Maximum height for panel exterior-mounted devices is 6'-0" from the floor. Minimum height for panel exterior-mounted devices is 3'-0" from the floor.
   5. Locate alarm horn at the top of the panel. The alarm horn may be located above 6'-0" device height limitation.
   6. Unless otherwise noted; route field wiring through the bottom of the enclosure. Provide watertight conduit openings.

B. Exterior Panel Nameplates
   1. General
      a. Refer to Section 2.1.D for material and size requirements.
      b. Provide specific panel identification on nameplates derived from the CONTRACT SPECIFICATIONS and DRAWINGS.
      c. Obtain ENGINEER approval for panel identification for panels that are not identified in the CONTRACT SPECIFICATIONS and DRAWINGS.
   2. Panel Manufacturer Identifier and Power Requirements Nameplate (NP-1)
      a. Mount nameplate in the upper left corner of the panel front.
      b. Provide the following information for each circuit feeding the panel.
   3. The first line indicates the name of the manufacturer, location and phone number of who assembled the panel.
   4. The following lines:
   5. Include panel voltage, current, phase, frequency, short circuit current rating for each panel feed.
   6. Provide switchboard name and circuit number for each circuit feeding the panel.
   7. Refer to figure 3.1.B.2

MITCHELL & SONS, TOLLESON, AZ - (602) 555-1212

120 VAC, 0.5 AMPS, 1Ø, 60HZ, SCCR 5KA, FED FROM LP-34, CIRCUIT 6

120 VAC, 7.5 AMPS, 1Ø, 60HZ, SCCR 8KA, FED FROM LP-34, CIRCUIT 8

Figure 3.1.B.2

Panel Manufacturer Identifier and Power Requirements Nameplate (NP-1)

8. Panel Identification Nameplate (NP-2)
9. Mount panel identification nameplate in the top, center of the panel.
10. Provide the following information:
11. The first line of text is an abbreviation of the panel as shown on the CONTRACT DRAWINGS.
12. The second line of text on the nameplate is used to spell out the process abbreviation.
13. Refer to figure 3.1.B.3.

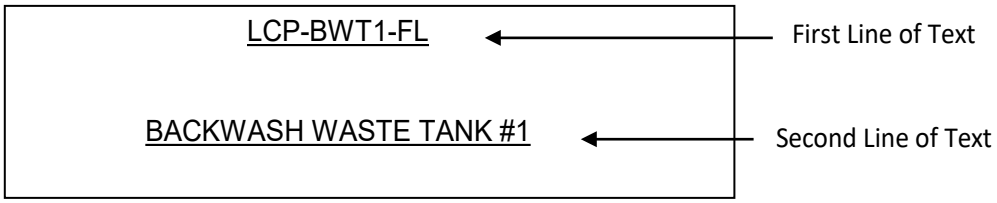

Figure 3.1.B.3

Panel Identification Nameplate (NP-2)

14. Panel Component Nameplates
15. Mount nameplates above all control and indicating devices.
16. Provide the following information:
17. The first line indicates the instrument device loop identifier and number as shown on the DRAWINGS.
18. The second line identifies the system equipment that the component is associated with.
19. The third line identifies the control position, condition of the equipment or the alarm state being monitored.
20. Refer to figure 3.1.B.4

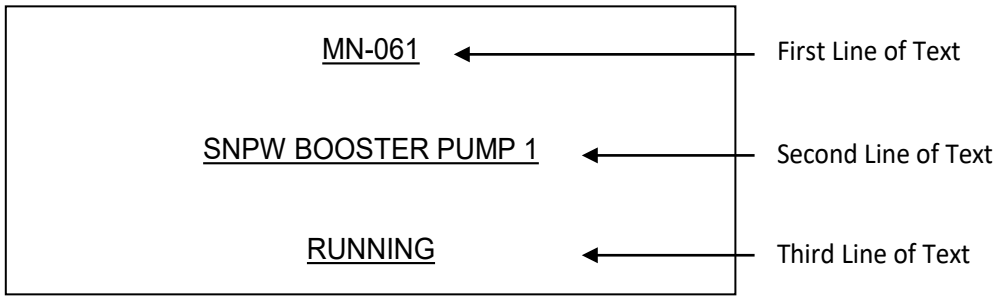

Figure 3.1.B.4

Panel Component Nameplates

3.2 INTERIOR PANEL

A. General:
   1. All Wall Mounted Panels - Where conduit enters the panel, maintain a minimum of 4" clearance from any device or wireway to allow room for routing of field wiring.
   2. Concrete Pad or Floor Mounted LCP's and MCP's – Where conduits enter the panel through the concrete pad, maintain a minimum of 6" clearance from any device or wireway to allow room for routing of field wiring. Where conduit enters the panel sides or top, maintain a minimum of 4" clearance from any device or wireway to allow room for routing of field wiring.
   3. Elevated Floor Mounted LCP's and MCP's - Where conduit enters the panel, maintain a minimum of 4" clearance from any device or wireway to allow room for routing of field wiring.
   4. Concrete Pad, Floor Mounted or Elevated Floor Mounted ITP's - Where conduits enter the panel through the top or bottom, maintain a minimum of 6" clearance from any device or wireway to allow room for routing of field wiring.
   5. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
   6. Maintain a minimum 2'0" clearance between components mounted on side panels and components mounted on the opposing side panel.
   7. Components mounted on the back panel are to be unobstructed by any components mounted on side panels.
   8. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

B. Panel Incoming Power:
   1. Panel power fed from lighting panels, or other sources with fused or circuit breaker protection, shall be wired to the Power Terminal Blocks (PTBs). Power sources entering the panel are to be provided with a separate neutral and ground. The PTBs shall have a separate terminal for the hot and neutral for each circuit. The ground to be terminated to the AC ground bar.
   2. Mount the PTBs near the top left corner of the panel.

3. Multiple power sources may be required for each panel. Power requirements are identified on the CONTRACT DRAWINGS. The following additional power sources may be required for the panel.
   a. Control Logic Power and Light Fixture
   b. Air Conditioning
4. Arrange the terminal strip in an orderly manner with circuit conductors grouped together. For instance, terminate the hot and neutral conductors on consecutive terminals. Label terminals and internal wiring as H1 and N1 (Control Logic), H2 and N2 (Air Conditioning). Identify each additional source in sequential order beginning with H3 and N3.
5. Terminate all incoming power on one side of the terminal strip.

C. AC Power Distribution:
   1. Identify the wire extending from the PTB to the supplementary protector as H1 and H2, etc. Using H1 as an example; the wire terminated to the line side of the supplementary protector is labeled H1, the wire terminated to the load side of the supplementary protector is labeled as L1-1.
   2. If L1-1 passes through an additional supplementary protector to feed panel components, this supplementary protector can be shown on the drawings in a horizontal or vertical position on a schematic rung and the wire terminated to the line side of the supplementary protector is labeled L1-1. The wire terminated to the load side of the supplementary protector is labeled L1 – (the Supplementary Protector #) and the wire color is black.
   3. If the panel controls multiple pieces of equipment, such as two pumps with separate control circuits, provide a supplementary protector for each control circuit.
   4. Powering 120 VAC field 4-wire instruments from the panel is not permitted.

D. DC Power Distribution:
   1. Mount DC power supplies near the top right of the panel. Mount fuses associated with the power supply in close proximity to the power supplies.
   2. Identify terminals used for DC power distribution as PTB-DC.
   3. Provide a fuse for each analog loop that loop power is provided by a power supply located in the panel.

E. Grounding:
   1. AC Ground:
      a. Provide the AC ground bus bar with cage type or screw terminals installed near the bottom of the back panel with extended mounting bolts.
      b. Provide adequate metal to metal contact between the AC ground bus bar and the back plane.
      c. Connect all AC power sources and devices to ground at this ground bus.
      d. Connect all panel enclosure doors to the AC ground bus.
      e. Connect all side panels to the AC ground bus.

f. **Provide a connection point on the ground bus for connection to the ground grid system.**

2. DC Ground:
   a. Install the isolated DC grounding bus bar with cage type or screw terminals installed near the bottom of the back panel at a minimum distance of 6” from the AC ground bus.
   b. The isolated grounding bus bar consists of two non-conductive mounting blocks with a single copper grounding bar attached between them.
   c. Connect all shields (SH) requiring loop grounding in the panel from the analog signal terminals to the DC grounding bus bar.
   d. To avoid ground loops, connect analog cable signal shields to ground at one location only, preferably in the LCP, MCP or ITP; not in the field. Maintain consistency for the termination point of signal shield for all analog signals.
   e. **Provide a connection point on the ground bus for connection to the ground grid system.**
   f. Figure 3.2 illustrates a typical ground system within a panel. The illustration depicts the physical terminations of the ground wires in the panel**.** Ground Conductor AWG size to ground grid system shall be as stated in Specification 26 05 26 – Grounding Systems.

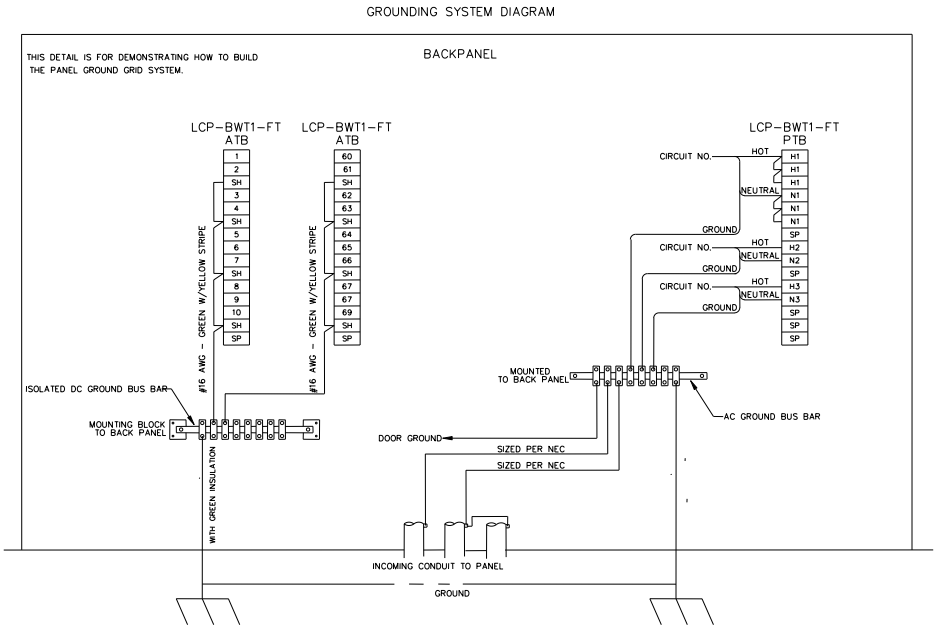

Figure 3.2

Typical Grounding Systems

F. Circuit Protection:
   1. Provide an isolating supplementary protector for each group of control logic. For example: the start, stop and reset control circuit for Pump #1 has a dedicated supplementary protector supplying power to the control logic. Pump #2 requires a separate isolating supplementary protector for the control logic.
   2. Provide an isolating supplementary protector for each component requiring 120 VAC power.
   3. A supplementary protector is not required for control circuits powered from a fused control power transformer in an MCP.
   4. Size supplementary protector to handle the connected load.
   5. Mount supplementary protector next to the PTBs near the top left corner of the panel.
   6. Provide an auxiliary contact for each supplementary protector. Wire each auxiliary contact from the supplementary protector in series to one “Power fail’ relay. Send one Power Fail status to the Computer Control System.

G. Internal Panel Wiring:
   1. Route all internal wiring using wireways. Terminate all internal wires on one side of the terminal blocks. The opposite side of the terminal block shall remain available for field wires.
   2. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
   3. Adequately support and restrain all wiring runs to prevent sagging or other movement. Wires extended from the control logic to the panel door devices are to be wrapped in plastic protective wire wrap designed for this purpose.
   4. Wire splicing is not allowed at any time.
   5. Utilize two wires (hot and return leg) with field wiring for each field input. It is not acceptable to utilize one common Hot for multiple field inputs.
   6. Terminate wires with an insulated ferrule type crimp connector. Excessive stripping of the insulation to allow bare wire strands between the insulation and the ferrule is not permitted.
   7. Orientate wire labels on the individual conductor or cable so that wire labels are legible without having to twist or move the connectors. Securely heat shrink the labels around the conductor. Label wires or cables with the number assigned in the panel documentation. Refer to Section 2.2.K.1.e for wire label materials.
   8. DC wiring for analog and discrete field or Computer Control System signals that enter or leave the panel are to be terminated on the Analog Terminal Block (ATB).
   9. AC wiring for discrete field signals that enter or leave the panel are to be terminated on the Terminal Block 1 (TB1).

10. AC wiring for discrete Computer Control System signals that enter or leave the panel are to be terminated on Terminal Block 2 (TB2).
11. The terminal blocks (TB1, TB2 or ATB) can be mounted on the left or right side panels.
12. Provide a minimum of 10% spare terminal DIN rail space per terminal strip.
13. Signals from the field that enter the panel and only pass through the panel from the field to the Computer Control System require internal wiring from TB1 to TB2.
14. Arrange all control wiring associated with a particular piece of process equipment together on adjacent terminal blocks.
15. Identify wire number by the schematic rung numbers. Label TB1 and TB2 terminals with the rung number associated with the internal wire number connected to the terminal. Label ATB terminals in sequential order starting with the number 1. Identify analog shield terminations with an “SH” on the terminal block.
16. Multi-conductor cables of two pair or more shall have the outer cable insulation removed before entering the wireway.
17. Route all DC power and analog signals at a minimum of six inches from AC power and controls. When the six inch minimum distance is not available, provide a metallic barrier that extends 3” beyond the tallest wireway between the analog and discrete wireways.

18. Wireways:
19. Mount wireways from the internal panel components and terminal blocks with a minimum 2” spacing.
20. Arrange wireways to maintain a six inch minimum distance between analog and discrete circuit wiring.
21. Provide wireways for all field wiring. Arrange wireways to allow field wiring to enter from the top or bottom of the panel.
22. Align wireways between back and side panels.
23. Install a wireway on both sides of each terminal strip.
24. Size wireways to prevent conductor fill from exceeding 50% of the interior cross-sectional area of the wireway.
25. In addition to the above requirements, for ITP’s, wireways are not to be common for two terminal strips. Each terminal strip shall have a dedicated wireway on each side of the strip.

H. Control Logic:
1. The Start commands are to be designed utilizing normally open contacts from pushbuttons and/or the Computer Control System and shall be of a momentary signal that will require a seal circuit to maintain operation. Constant signals from positions switches are not allowed unless noted on the CONTRACT DRAWINGS.
2. All system failure, safety logic control devices or normal operations that are

intended to cause the equipment to stop are to be wired in series with the start seal circuit. The unsealing of the start command on any fault or normal operation that causes the equipment to stop will require another start command to reseal.

3. Provide interlocks for the control functions of Local and Computer Modes in series with the Start and Stop logic. Provide a closed switch or relay contact to the Computer Control System to identify when the equipment is in Computer Mode.
4. Provide control logic of voltage 120 VAC. Exceptions must be approved by OWNER
5. Use power relays when control relay contacts are insufficient for the designated load.
6. Terminate the “Hot” conductor on the common of the switch or relay contact.
7. Control alarm logic shall be wired in a fail-safe mode from the field device to the panel circuitry to alarm when a field wire has failed.

3.3 PANEL DRAWING DOCUMENTATION

A. General:
   1. Files of the title block, panel symbols for front and internal sub-panel elevations, terminal strips, control schematics, analog loops, etc. are available in hard copy and AutoCAD .dwg format from the OWNER upon request through the ENGINEER via Example Panel Drawing Packages and Drawing Templates.
   2. Provide drawing copies in the following format:
      a. Hard Copy - B Size - 11” X 17”
      b. Hard Copy - D Size - 22” X 34”
      c. Soft Copy in .DWG
   3. The panel drawing documentation package consists of the following drawings types arranged in the following order.
      a. Cover Sheet
      b. Symbols and Legends 1 – Exterior and Interior Panel Symbols
      c. Symbols and Legends 2 – Schematic Symbols
      d. Front Panel Elevation
      e. Interior/Sub Panel Layout
      f. Terminal Strip Drawings
      g. Control Schematics
      h. Analog Loop Diagrams
   4. Drawing Scale:
      a. Provide Front Elevation and Interior/Sub Panel Layout Drawings proportionately correct and to scale. Create all drawings on a D Size layout.
   5. Border and Title Block:
      a. Provide each drawing with a border and title block information.
   6. Utilize the border and title block as provided in the Drawing Templates referenced in Section 3.3.A.1.

7. Panel Drawing Types:
8. General:
    a. Provide a complete documentation package for each panel consisting of the drawings in the order listed in Section 3.3.A.3.
9. Cover:
    a. Cover sheet for the panel documentation shall include the following information.
        1) Located on the left half of the sheet to include the Manufacturers Name, Address, Phone Number, Web Address, Project Reference Number and UL508A Certification Number.
        2) Located on the right half of the sheet include the title “City of Phoenix” “Water Service Department” and the project title, City of Phoenix project number, the panel full title, the panel abbreviation, the facility area in which the panel exists, submittal date, volume number and sheet count.
10. Symbols & Legends
    a. Utilize the Symbols and Legend sheets as provided by the OWNER upon request from the ENGINEER.
    b. Additional symbols may be added if an existing symbol on the Symbol and Legend sheets does not exist.
11. Front Elevation Drawing
12. The Front Elevation drawing illustrates the arrangement of the panel and position of the devices on the front face of the panel.
13. Provide panel dimensions in inches. Provide dimensions for height, width, and depth. If the panel is small in size, the Front Elevation Drawing and Internal layout Drawing can be combined on one drawing.
14. Provide the nameplate schedule on the Front Elevation drawing.
15. Device Callouts
        1) Device callout hexagons are utilized to reference a device to the bill of materials. Place the bill of material item number inside the hexagon.
        2) Provide a leader from the hexagon that will point to the device.
        3) For a typical of multiple devices of the same type, only one device callout is necessary.

16. Interior Sub Panel Layout:
    a. General:
17. The Interior Sub Panel Layout drawing identifies the individual interior components and their physical location.
18. Draw all components within the panel to scale.
19. Include all interior sub panels if the panel has sub panels on the side walls.
    a. Provide the following information on the Interior Sub Panel Layout Drawing. Utilize the formats provided on the Drawing Templates. The

information can be shown on a second sheet if needed due to drawing clutter.

1) Bill of Materials
    a) Include all devices on the Front Panel Elevation and the Interior Sub Panel(s) Elevation.

20. Include items that are not specifically shown on the Front Panel Elevation or the Interior Sub Panel Layout drawing, such as wire size, color and type, on the bill of materials.
21. The utilization or insertion of Microsoft Excel files for the Bill of Materials is not allowed.
    1) Fuse Schedule
    2) Supplementary Protector Schedule
22. Label and identify all devices, including terminal strips, relays, fuses, timers, power supplies and other special components on the drawing.
23. For unique devices not shown on the Symbols and Legend Sheets, use rectangles and squares with the appropriate dimensions of the device.
    a. Device Callouts
        1) Device callout hexagons are utilized to reference a device to the bill of materials. Place the bill of material item number inside the hexagon.
        2) Provide a leader from the hexagon that will point to the device.
24. For a typical of multiple devices of the same type, only one device callout is necessary indicated by (typ) near callout hexagon.
25. Terminal Strip Drawing:
    a. General:
26. Terminal Strip Drawings provides locations for wiring terminations from field devices and other equipment external to the panel.
27. Display the wiring connections exactly as they are physically installed. For example, if field wiring is terminated to the left side of the terminal strip, the terminal strip drawing displays the wiring connections to the left side of the terminal block.
28. There are 6 different types of terminal strips and each has a specific function. The following is a brief description of each:
        a) For LCP's and MCP's:
            i. Power Terminal Block (PTB) – Power supply/supplies to the panel (120 VAC or higher). Identify terminal block number with the wire number assigned in the control logic drawings. Identify power sources with the originating panel, voltage and circuit number.
            ii. Field Wiring Discrete Signal Terminal Blocks (TB1) – Discrete field inputs and outputs to/from the panel. Identify terminal block number with the rung number assigned in the control logic drawings.
            iii. Field Wiring Discrete Signal Terminal Blocks (TB2) – Discrete inputs and outputs to/from the Computer Control System. Identify terminal block number with the rung number assigned

in the control logic drawings.

iv. Field Wiring Analog (ATB) or Internal Wiring DC Power Terminal Blocks - Field or Computer Control System Analog inputs and outputs to/from the panel, including 4-20 mA, 1-5 VDC, thermocouple or Resistance Temperature Detectors (RTD's). Identify terminal block number with consecutive numbers starting with number 1. The shield wire terminal block is to be label "SH".

b) For ITP's:

i. TB-A thru Z – Discrete field inputs and outputs to/from the panel.

ii. ATB-A thru Z – Analog inputs and outputs to/from the panel.

29. It is acceptable, if space available, to combine TB1, TB2, ATB and PTB on a single terminal strip drawing.
30. Identify spare terminals with an "SP" inside the rectangle.
31. Display terminals in the order they appear in the panel.
32. Place field wire labels on each line extending toward the terminal. Obtain this information from the cable and conduit schedules. If wire labels are unavailable, place seven "X's" where wire tag normally resides. Provide this information prior to final deliverable of the Operations & Maintenance Manuals.
33. Signal description consists of 3 lines of text. Center the text next to the terminals.
    a) The 1st line of text lists the Equipment Name.
    b) The 2nd line of text is for the Signal Function.
    c) The 3rd line of text is the Signal Loop Number, if applicable.
34. Control Schematic:
    a. General:
35. Control Schematics show the controls associated with pieces of process equipment and provide a visual depiction of the majority of control wiring.
    a. Control Schematic Components:
36. Power Rail:
    a) Represent the power rail with two parallel vertical lines that extend vertically down the schematic.
    b) Each drawing includes two sets of power rails separated by 2.5".
    c) Identify each power rail with the wire number such as L1 at the top and bottom of each power rail.
    d) The left power rail represents the "Hot" side of the power source. The right power rail represents the "Neutral" side of the power source.

2) Power Source:

a) Identify power source(s) with the originating panel, voltage and circuit number between the "Hot" terminal and "Neutral" terminal on the first rung of the portion of the schematic for each source.

b) Indicate the terminals from the PTB providing the source and neutral powering the rail.
c) A supplementary protector or fuse is displayed in the power rail directly below the power source (Hot) terminal. Label the supplementary protector or fuse with the supplementary protector or fuse number and current rating.
d) Power layout for LCP's:
   i. In the first portion of the schematic, display power to the general purpose receptacle and panel light.
   ii. In the second portion of the schematic, display power to the air conditioner and/or heater.
   iii. In the third portion of the schematic, display the power to the control logic.
   iv. See Sections 3.2.B Panel Incoming Power and 3.2.C AC Power Distribution.
e) Power layout for MCP's:
   i. The first portion is for the typical 480 VAC motor control circuit with starter and disconnect, the next sections are the same as for the LCP's.

3) Rung Number:
   a) Rung numbers are used to identify the location and cross referencing of devices within the schematic and provide a practical means of labeling conductors and terminals within the panel.
   b) Rung numbers are a sequential series of numbers starting with number 1. Locate the numbers vertically along the left side of the "Hot" power rail.
   c) Rungs are to be spaced on 0.5" centers based on a D Sized drawing.
4) Wire Numbering:
   a) On the downstream side of the first device on a rung, the wire number takes the rung number appearing to the left of the power rail. If a second device is located in the circuit, the wire number to the right of the second device takes the rung number, but is appended with an "A". The wire number to the right of the third device is appended with a "B", and so on.
   b) When the electrical connection originated on the previous rung, the wire numbers continue to use the previous rung number as the base.
   c) Connections to the power neutral rail take on the power neutral rail's wire number N#.

37. Electrical Connections:
   a) Represent electrical connections as a solid small circle where two or more wires interconnect.

b) Represent electrical connections as a hollow small circle where wires terminate to a device.

38. Electrical Wiring:
    a) Electrical wires or circuits are represented by horizontal rungs that connect terminal blocks, relays, contacts and all other components used in the electrical schematic.
    b) Space the schematic electrical wiring every other rung at a minimum.
    c) Identify each wire with the rung number as the wire number.
    d) Label each wire with the conductor insulation color below each electrical wire. Refer to Table 2.2.K.1.f.
    e) Indicate electrical wiring that is external to the panel with dashed lines.
    2) Device Labeling:
        a) Device symbols in the schematic for field devices, pilot lights, switches, push buttons etc. requires two lines of text above the device and one line of text below the device to describe the usage of the device.
            i. The first line of text above the device is the name of the equipment the device is associated with.
            ii. The second line of text above the device is the control function of the device.
            iii. The line of text under the device is the loop number.
        b) Relay and timer symbol labels are to be identified with consecutive number starting with the number 1 or the rung number. For relay coils and contacts, identify the relay base terminal connection. Normally open or normally closed contacts refer to the de-energized or “off the shelf” state.
        c) Symbols in the schematic for contacts of relays, timers, etc. require two lines of text above the contact and two lines of text below the contact to describe the usage and coil reference of the contact.
            i. The first line of text above the contact is the name of the equipment the device is associated with.
            ii. The second line of text above the device is the control function of the device.
            iii. The first line of text under the device is the relay or timer number to reference the relay or timer in the schematic.
            iv. The second line of text under the device is the rung number of the relay or timer to reference where the relay or timer is located in the schematic. If using the rung number for the relay or timer coil, the rung number under the contact is not required.
            v. For relays and timer contact references, at the right of the

neutral power rail, the schematic rung number location of all associated contacts is shown. If the contact is normally closed, underline the reference number. If a contact is unused, “SP” is shown.

39. Field Contacts:
    a) Show Field Contacts connected to their respective TB1 or TB2 Terminals.
    b) The connection lines from the contact to the terminal are dashed to designate they originate from outside the panel.
40. Selector Switches:
    a) Always show the switch in the far-left position, the switch contacts are shown as either opened or closed in this state. If they’re in the closed state, the contact is shown closed, indicated by a line shown below and touching the two side small circles. If the contact is open in this position, a line is drawn above the two side small circles, but not touching them.
    b) Show each position of the switch directly above its respective location on the switch. This indicates whether it is a two, three, four, or more position (pole) switch, and shows what the nameplate on each position will read.
    c) To indicate which positions the contact is closed, show a contact legend in parenthesis below and to the right of the contact. If the contact is closed in a position, an “X” is shown in the order of the contact position in which it is closed. If the contact is open in a position, an “O” is shown.
    d) When a selector switch is continued onto another sheet or further down on the same sheet, the continuation note is shown below the selector switch. Where the switch is continued, the same note appears, but on the top of the contact.
41. Push Buttons:
    a) Represent the push button contact in its “off the shelf” state.
42. Terminals:
    a) Terminal numbers are dependent upon the specific rung number that they appear in the schematic logic. As a horizontal electrical connection is followed from left to right, the first terminal number takes on the number of the rung. The second terminal number also takes the rung number but is appended by the letter A, the third by the letter B, and so on.
43. Programmable Logic Controller:
    a) Panels that contain a Programmable Logic Controller (PLC) require connection information for the PLC I/O modules.
        i. Utilize the PLC drawings as provided in the Drawing Templates referenced in Section 3.3.A.1.a.
    b) Module Layout:

i. Represent the module with a 1 1/2" wide vertical rectangle with a length suitable to encompass a maximum of 16 channels or 8 analog per section based on type of module. Two cards can be shown per sheet.
ii. Display field wiring (inputs) including TB1 and field device connections with a description on the left side of the module symbol.
iii. Label the module with model number, input voltage, rack number and slot number above the module symbol.
iv. Number each screw terminal per manufacturer's data.
v. Display the associated PLC register address with each signal.
vi. Identify the positive and negative legs of the analog cable.
vii. Include all required jumpers for signal type and all 120VAC and 24VDC power requirements.

2) 480 Volt Equipment:
   a) Provide the motor horsepower, full load amps and motor identification.
3) Contact Development:
   a) The last sheet of the control schematic displays contacts for internal panel relay contacts that connect with external field equipment or the Computer Control System (CCS).
   b) Organizes into two sections. The first section lists all contacts extending to the CCS. Title this section "Contacts to CCS". The second section lists all contacts extending into the field equipment external to the panel. Title this section "Contacts to Field". Group multiple contacts related to a single piece of equipment together.
   c) Each contact includes a signal description and its associated relay number and relay rung number location. Device signals require the appropriate symbol from the Schematic Legend Sheet.

44. Analog Loop Diagrams:
   a. General:
      1) The analog loop diagram only displays the portion of the instrument loop that passes through a particular panel.
      2) The analog loop diagram displays the connections between field instruments, panels and the CCS.
      3) Analog loop diagrams are reserved for analog signals and control loops, but may be used to show complex connections for a particular instrument or device.
      4) Divide each loop into three different segments.
         a) The left segment is "FIELD" connections. This segment provides information on terminations external to the panel (i.e., connected

panels, instrument transmitters). If the first segment is another panel, the panel name replaces the “FIELD” label.

b) The center segment is the internal panel wiring and controls.

c) The right segment information represents output or input signals to downstream panels or the CCS.

5) Identify shield grounding location.

6) Identify surge protection devices for each signal. Include surge protection for positive and negative leads. Utilize the surge protection block symbol from the legends and symbols sheet.

7) Identify the cable number, wire color and polarity for each cable in the loop.

3.4 INSTALLATION

A. Install equipment in conformance with NEC. Mounting panels on handrails is not allowed. Mounting panels below grade or in pits will require exception from the OWNER.

B. Unless otherwise noted, install indoor free-standing panels on 4-inch concrete pad. Extend pad 4-inches beyond outside dimensions of base, all sides. Lay grout after panel sills have been securely fastened down.

C. Unless otherwise noted, install outdoor free-standing panels on a reinforced concrete pedestal:
   1. Minimum Thickness: 8-inches with No. 4 steel reinforcing bars at 12-inches on centers, each way.
   2. Minimum Size: 4-inches larger than outer dimensions of base, all sides.
   3. Provide excavation and backfill work in conformance with Section 02315, Structural Excavation and Backfill.
   4. Provide concrete work in conformance with Section 03 30 00, Cast-In-Place Concrete.
   5. Seal the contact surface between the panel base and concrete surface with a gasket, gasket sealant and along the outside perimeter of the panel using RTV sealant.
   6. Install anchor bolts and anchor in accordance with Section 05 05 19, Anchor Bolts, Toggle Bolts and Concrete Inserts.

D. Elevated Panels with floor stands:
   1. When installing conduits through bottom, utilize bushings to retain the NEMA rating of the panel.

E. Install each item in accordance with manufacturer’s recommendations and in accordance with the Contract Documents.

3.5 RECORD DRAWINGS:

A. Maintain a set of red-line panel drawings to reflect changes or deviations that occur during installation, start-up and commissioning and incorporate these deviations into the final Operation & Maintenance Manual.

B. Provide record drawings in accordance with Section 01 78 39, Record Documents

3.6 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, identical and interchangeable with similar parts furnished under this Specification. Comply with the requirements of Section 01 78 43, Spare Parts and Maintenance Materials.

B. Pack spare parts in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. The following constitutes the minimum spare parts:
   1. Five of each type of control relay for each 40 or less furnished for this Contract.
   2. One replacement power supply for each type and size furnished for this Contract.
   3. One per ten (two, if fewer than twenty) of each type of panel mounted instrument including lights and pushbuttons.
   4. One dozen of each type and size of fuse used in panels and instruments.

D. The following constitutes the minimum test and calibration equipment:
   1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors.
   2. All special calibration equipment required for system calibration.

3.7 TESTING AND ADJUSTMENTS:

A. Perform system testing and make any adjustments necessary in accordance with this Section and Section 40 61 13, Process Control System General Requirements.

B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

C. A Factory Acceptance Test shall be conducted before the panel is shipped to the site. The Factory Acceptance test shall be witnessed by the ENGINEER and OWNER. The Factory Acceptance Test Report listed in Specification Section 01 33 10, Reference Forms – Form 40 67 00-A shall be utilized to document the test.
   1. Factory Acceptance Test to be witnessed by ENGINEER and OWNER.
   2. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform factory testing, before shipment, at the manufacturer's facility to verify that system components are functioning

properly and that they meet the functional and performance requirements of the Contract Documents.

3. Submit information on factory testing procedures to verify that testing shall fulfill the requirements as specified herein. Submittal shall be made at least two months in advance of any scheduled testing and shall include dates of scheduled tests.
4. Notify ENGINEER, in writing, at least four weeks before expected initiation of tests. OWNER and ENGINEER may elect to be present at CONTRACTOR'S facilities during operational test of system equipment, either for individual units or as an integrated system. Presence of OWNER and ENGINEER during testing does not relieve CONTRACTOR from conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the equipment.

D. System Hardware Operational Testing
1. All input/output devices and components shall be tested to verify operability and basic calibration.
2. All system hardware components equipment shall be tested to verify proper operation of the equipment as stand-alone units. Test shall include, but not be limited to, the following:
   a. AC/DC power checks.
   b. Power fail/restart tests.
   c. Diagnostics checks.
   d. Test demonstrating that all specified equipment functional capabilities are working properly.
   e. All system components shall be tested to verify that communication between units is working properly.

3.8 MANUFACTURER'S SERVICE

A. Provide the services of qualified factory-trained service representative to check and approve the installation of the panel(s).

B. The factory trained service representative shall be provided for installation supervision, start-up and testing services. The representative shall make a minimum of five (5) visits to the site to approve the completed installation and to perform start-up testing of the equipment. The representative shall coordinate each visit with the ENGINEER prior to arrival on the site. The representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to requirements. The representative shall revisit the job site as often as necessary until the installation and testing is entirely satisfactory.

C. The factory trained service representative shall be provided for operation and maintenance personnel training services. The representative shall make a minimum

of three (3) visits to the site to perform the services as described under Section 01821, Instruction of Operations and Maintenance Personnel. The representative shall coordinate each visit with the ENGINEER prior to arrival on the site.

D. For the factory trained service representative, all costs, including travel, lodging, meals and incidentals, shall be considered as included in the bid price.

E. Warranty: Minimum 1 year from final startup date or as specified in N.T.S. or in the contract specifications, whichever is longer.

++ END OF SECTION ++

SECTION 40 68 70

PLC'S – SOFTWARE AND PROGRAMMING

PART 1 - GENERAL

1.1 SCOPE

A. Contract documents illustrate and specify general requirements of the Programmable Logic Controllers (PLC), Operator Interface Terminal (OIT), software, networking, and programs, and does not necessarily show or specify all components, wiring, and accessories required for a completely integrated system.

B. Provide all labor, materials, equipment, documentation, furnish, install, calibrate, test, start-up, program, configure, commission, and place into satisfactory operation of all PLCs, OITs, networking hardware, **signals and programming at SCADA/CCS**, software, and programs.

C. Conform the design and programming of all PLCs, OITs, software, and programs to the specifications herein.

D. Provide all necessary tools, such as cabling, software, etc., as required to fulfill the programming requirements of the contract documents.

1.2 COORDINATION

A. Coordinate the installation of all items specified herein as required to ensure the complete and proper functionality of all PLCs, OITs, software, programs, networking, and accessories.

B. Provide all PLCs, OITs, software, networking and programs to meet the functional requirements as detailed in Section 40 61 96 – Process Control Descriptions and depicted on CONTRACT DRAWINGS.

C. Install and wire all Inputs/Outputs (I/O) as specified in Section 40 67 00 – Process Control System Panels and Enclosures.

D. Install PLCs or remote I/O in control panels with voltages of 120 VAC or less.

E. Relinquish all usernames and passwords to the OWNER, this includes but is not limited to all hardware, software, and programs. All usernames and passwords are property of the OWNER.

F. Provide separate 120 VAC receptacles in the control panel for PLC hardware with 120 VAC receptacle outlet plugs. Label each receptacle's use, i.e. "For fiber

Optic Converter Use Only". Provide an isolating supplementary protector for each receptacle.

G. Provide all PLC and OIT hardware and accessories with Heresite conformal coating, or equal protection, against hydrogen sulfide levels up to seven ppm. Verify all PLC and OIT model numbers are Heresite conformal coating model numbers.

1.3 DEFINTIONS

A. **Distributed I/O:** Hardware that has been specially designed to function as Remote I/O.

B. **OIT:** Operator Interface Terminal, sometimes referred to as Human-Machine Interface (HMI).

C. **Peer-to-Peer:** Communication between two or more devices, typically PLCs, in which each device can control the communication exchange.

D. **PLC:** Programmable Logic Controller.

E. **Remote I/O:** Remote I/O is any and all I/O that is located remotely from the processor. Remote I/O can be over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.

1.4 QUALITY ASSURANCE

A. Reference Standards:
1. PLCs, OITs, networking hardware, software, programs and accessories must comply with applicable provisions of the following, except where otherwise shown or specified.
2. International Electrotechnical Commission (IEC).
3. American National Standard Institute (ANSI).
4. Institute of Electrical and Electronics Engineering (IEEE).
5. National Electrical Manufacturer's Association Standards (NEMA).
6. Operational Safety and Health Administration (OSHA) Regulations
7. State and local code requirements.
8. Where any conflict arises between codes or standards, the more stringent requirement applies.
9. Provide all panel devices with the label of the Underwriters' Laboratory (UL), Inc. Document the UL/UR listed number on the Bill of Materials (BOM) on the control panel drawings.
10. National Fire Protection Agency (NPFA).
11.

1.5 SUBMITTALS

A. Submittals:
   1. The PLC submittal requirements are to be submitted with the control panel submittal package. Reference Section 40 67 00 – Process Control System Panels and Enclosures.
   2. Provide the manufacturer's technical data sheets, cut sheets, and product literature for all PLCs, OITs, networking hardware, software, programs, and accessories. Clearly identify exact equipment and materials that are being supplied on the manufacturer's data sheets.

B. PLC Program Coordination Workshop:
   1. Conduct a program software coordination workshop with the PLC PROGRAMMER, ENGINEER, and OWNER prior to shipment of the equipment.
      a. Workshop Agenda:
         1) Review the control logic and function block programming styles.
         2) Review the PLC I/O signal list.
         3) Review the hardware configuration.
         4) Review the network configuration.
         5) Review CONTRACT DRAWINGS and Section 40 61 96 – Process Control Description.
      b. Attendees:
         1) PROGRAMMER/CONTROL PANEL SUPPLIER
         2) CONTRACTOR
         3) OWNER
         4) ENGINEER
   2. Conduct a minimum of an eight (8) hour workshop on site, unless stated otherwise. This workshop is to ensure that the software code, OIT screens, hardware configurations, and addressing are compatible with the OWNER'S systems.
   3. Provide four (4) hard copies and four (4) soft copies of all OIT screens and PLC programming with addressing, comments, and descriptions at a minimum of two (2) weeks prior to the workshop.
   4. Provide workshop meeting minutes and action items.

1.6 O&M MANUALS

A. Comply with the requirements of Section 01 78 23 – Operations and Maintenance Data and the following:
   1. Provide a hard copy of all PLC programs complete with comments and address descriptions.
   2. Provide a compact disc (CD) with a copy of all OIT screens and PLC programs with complete annotated documentation and READ/WRITE access to the PLC programs. Relinquish all rights of the program to the OWNER.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLERS

A. General:
1. Utilize M580 PLCs.
2. Provide PLCs with the following functionality:
   a. All operational, protective, status, and alarm functions as described per Section 40 61 96 – Process Control Description, 40 67 00 – Process Control System Panels and Enclosures and the CONTRACT DRAWINGS.
   b. Perform process control functions, data collection, communicate with other PLCs, and distribute process information along the local area network (LAN).
   c. Capable of stand-alone operation during any communication failure.
   d. Capable of downloading and uploading programs from a remote workstation over the LAN and locally programmed from a portable laptop computer.
   e. Field expandable to allow for the growth of the system by simple addition and configuration of hardware.
   f. I/O modules are capable of insertion and removal under power.
   g. I/O modules can only be inserted one direction to prevent improper installation of modules.
   h. Key all modules and connectors to safeguard against improper insertion of a module into the backplane slot.
   i. Each component must include a clearly visible faceplate with appropriate data such as the manufacturer's model number and a brief description of the component's functionality.
   j. Provide all cables and connectors as specified by the manufacturer. Assemble and install cables per the manufacturer's recommendations.
   k. Provide configurable alarming capability. Each alarm point can be configured to display an alphanumeric message in the alarm buffer. The alarm buffer can be displayed from a web page, or an OIT.
3. PLC Module Fusing:
   a. Provide each analog and discrete I/O module with at least one properly sized fuse per module voltage source.
4. Surge Protection:
   a. Provide DC surge protection for all analog signal loops that are terminated to Programmable Logic Controllers.
   b. Provide a separate surge protector for the positive and a separate surge protector for the negative.
   c. Purchase and mount surge protector as stated in Specification Section 40 67 00 – Process Control System Panels and Enclosures. Meet the following for PLCs utilizing Ethernet protocols:

d. Protocols that are assigned to port 502 of the transmission control protocol/internet protocol (TCP/IP) stack by the Internet Assigned Numbers Authority (IANA).
e. Devices must utilize embedded web pages, or a physical means such as DIP switches, to be recognized and properly addressed on the network. Ethernet protocols that require network management software, or utilize configuration files that must be downloaded to Ethernet devices, for proper network addressing, and recognition are not acceptable.
f. Provide an Ethernet networking connection either built into the central processing unit (CPU) or via an Ethernet networking module.
g. Provide all equipment from non-third party vendors to meet the above criteria.

5. Virtual private network (VPN) access is NOT granted for offsite configuration, programming, troubleshooting, testing, and/or support.

B. M340 PLCs (M340 PLC Not used for this project):
1. Provide one of the following Modicon M340 CPUs:
a. BMX P34 2020H
b. BMX P34 30302H
2. Provide one of the following Modicon Ethernet Backplanes:
a. BME XBP 0400H
b. BME XBP 0600H
c. BME XBP 0800H
d. BME XBP 1200H
3. Provide M340 PLCs with a chassis mounted power supply to power the backplane, processor, and modules. Provide a power supply with enough capacity to power existing modules plus any similar future modules. Provide one of the following:
a. BMX CPS 3500H
b. BMX CPS 3020H
4. Communication Modules:
a. Provide one of the following Ethernet Modules for M340 PLCs if additional ports are needed.
1) BMX NOE 0100H
2) BMX NOE 0110H
b. Provide the following Serial Module for M340 PLC’s if additional ports are needed.
c. BMX NOM 0200H
5. Communication Standards:
a. Provide the following additional communication capabilities for M340 PLCs with an Ethernet port:
6. Modules:
a. Provide the following modules as needed to meet the requirements of the CONTRACT DOCUMENTS:
b. Analog Inputs Module:

1) BMX AMI 0410H
c. Analog Input HART Module:
1) BME AHI 0812
d. Analog Outputs Modules:
1) BMX AMO 0410H
2) BMX AMO 0802H
e. Discrete Inputs Module:
1) BMX DDI 1602H
f. Discrete Outputs Modules:
1) BMX DDO 1602H
2) BMX DDO 1612H
3) BMX DRA 1605H
g. Application Specific Modules:
1) BMX EHC 0200H
2) BMX EHC 0800H
h. Fiber Converter
1) BMX NRP 0200 multi-mode
2) BMX NRP 0201 single-mode

C. M580 PLCs:
1. Provide one of the following Modicon M580 CPUs:
a. BME P58 1020H
b. BME P58 2040H
c. BME H58 4040H
2. Provide one of the following Modicon Ethernet Backplanes:
a. BME XBP 0400H
b. BME XBP 0600H
c. BME XBP 0800H
d. BME XBP 1200H
3. MODULES: The M580 and M340 use the same Modicon X80 I/O platform. Refer to paragraph 2.1.B.6 for modules.
4. Redundancy:
a. Provide redundant capable processors without requiring a separate redundancy module.
b. Communicate via fiber optic cable or Ethernet cable attached directly to the processor for redundant communication between PLCs.
c. Provide the primary processor with the capability to automatically transfer its program to the standby processor upon replacement. Systems that require special programming software, physical media, or manually initiated method to load the program into the standby processor are not permitted.
d. Provide redundant capable processors with a coprocessor to handle communications between the primary and backup processor. Provide a coprocessor to allow communications to occur simultaneously to the program scan.
1) Controllers that stop program execution to perform communication transfer are not permitted.

2) Primary to backup communications that limit processor program scan times are not permitted.
3) Controllers that rely on scan time management techniques to minimize scan time are not permitted.
4) Controllers that caution against scan dependent logic are not permitted.
5) Processors that require doubling tag count compared to a non-redundant version are not permitted.

e. Provide redundancy systems that require remote I/O to contain all inputs and outputs to ensure proper transfer to the hot standby PLC.
f. Provide redundancy systems that allow for outputs to transition from primary to backup control without momentary lapse or bump. Provide bumpless outputs placed in main program. Processors whose bumpless integrity requires outputs to be placed in a single file or a file with a highest priority are not permitted.
g. Processors that have a delay or pause for cached or uncached messages are not permitted. Processors that allow messages to become inactive during switchover are not allowed.
h. Redundant controllers that stop backplane communication for diagnostic or switchover purposes are not permitted.
i. Provide primary and standby processors that automatically synchronize. Processors that require manual synchronization are not permitted. Processors that allow deactivation of automatic synchronization are not permitted.
j. Provide Ethernet communication to peer-to-peer devices including OITs and other PLCs for redundancy systems. Controllers that can have message communications outages over Ethernet are not permitted.

5. Remote I/O:
   a. An M580 CPU will be required.
   b. Provide only an Ethernet backplane for the head PLC and Remote I/O drops.
   c. Provide a BME CRA 31210C remote drop adaptor with Ethernet backplane for all remote drop applications.
   d. Create a daisy chain loop using copper or fiber depending on the distance from the main local rack and the RIO drop. A copper cable connection between two consecutive RIO drops cannot exceed 100 m (328 Ft.). A fiber cable connection between two consecutive RIO drops cannot exceed 15 km (9.3 mi.) (single mode) or 2.5 km (1.5 mi.) (multi-mode).
   e. Use CAT6e Gigabit (1000BASE-T) copper cables.
   f. Install fiber in accordance with 17101 standards.
6. Communication/Specialty Modules:
   a. BMX NOM 0200H
   b. BME NOR 2200H
   c. BME NOC 0321C Gig Speed
   d. BME ART 0814H
   e. BMX EHC 0200H

f. BMX EHC 0800H

D. Chassis I/O Sizing:
1. General:
a. Size the PLC chassis to handle the required I/O plus all spare I/O. When calculating spare I/O points, all fractional I/O points must be rounded up to the next whole I/O point. Provide the PLC chassis to be capable of handling all required and future like I/O modules. Group similar module types together.
b. Stored according to Section 01 66 00 – Product Storage and Handling Requirementst, all unpopulated I/O modules.
2. Use the following criteria when calculating the spare I/O:
a. Analog Inputs (AI): twenty (20) spare AI required.
b. Analog Outputs (AO): twenty (20) spare AO required.
c. Discrete Inputs (DI): twenty (20)spare DI required.
d. Discrete Outputs (DO): twenty (20) spare DO required.
e. Specialty: One (1) of each spare communication/specialty required.

E. Chassis Layout:
1. General Chassis Layout:
a. If the power supply is not integrated into the chassis, install the power supply in the first slot (Slot 0).
b. Install the CPU to the right of the power supply in slot 1.
c. Install the Network Over Ethernet (NOE) module for networking, to the right of the CPU.
d. Install any specialty modules if applicable, to the right of the NOE module.
e. Install all DI modules to the right of any specialty modules. If there are no specialty modules install all DI modules to the right of the NOE module.
f. Install all DO modules to the right of the DI modules.
g. Install all the AI modules to the right of the blank module or DO modules.
h. Install all the AO modules to the right of the AI modules.
i. 1). If the analog and discrete modules use different voltage signals then install a blank module or leave an empty slot between the analog and discrete modules.
2. I/O types associated with a device (i.e. pump or blower):
a. Place on the same input module all inputs of the same I/O type.
b. Place on the same output module all outputs of the I/O type.
3. Remote I/O for Excess I/O or Redundancy:
a. If a PLC’s local I/O modules exceed their capacity of the local backplane, connect excess I/O to remote I/O. Place all I/O in remote I/O racks for redundant configured PLCs.
b. Connect remote I/O to the PLC through a remote I/O module with a minimum data transfer rate of 1.5 Mbaud to all remote I/O racks. Provide all PLCs with the capability of supporting up to 31 remote I/O drops.

F. Wiring:
1. In addition to Section 40 67 00 – Process Control System Panels and Enclosures, ensure all thermocouples and resistive temperature devices (RTD) are wired directly to the PLC.
2. Wiring spare I/O is not permitted, unless Advantys Telefast wiring and Adavantys Telefast ABE7 sub-bases are used.

G. PLC Environmental Requirements:
1. All PLCs must meet or exceed the following environmental requirements:
a. Minimum temperature range:
1) Operating: 0-55° C (+32 to +131° F)
2) Storage: -23 to +70 ° C (-13 to +158 ° F)
b. Relative humidity: 30 to 95% non-condensing
c. Altitude:
1) Operation: 0-6,500 feet minimum
d. 2) Storage: 0-9,800 feet minimum
e. Degree of protection: NEMA 1(IP20)
f. Vibration resistance in accordance with at least one of the following installed rating:
1) DIN rail mounted PLC: 10-57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz.
2) Panel or plate mounted PLC: 2-25 Hz, amplitude 1.6mm, acceleration 25-200 Hz.
3) In compliance with IEC 60068 and IEC 61131.
g. f. Shock resistance: 147m/s^2 for 11ms.
2. Environmental Limitations:
a. Equipment should be rated for continuous operation, capable of driving full load without derating, under the required conditions:

H. Overall PLC System Protection:
1. Provide the PLC CPU with the capacity to read the inputs, perform any system logic, conduct on-line diagnostics, and control the outputs. Diagnostics includes memory checks, communication motoring, I/O bus monitoring, watchdog timing, and user program validation. Provide diagnostic information accessibility from the program, programming software, or remotely from the OIT.
2. Provide the PLC CPU with the capacity of monitoring the health and status of every module in both the local and remote I/O backplanes. Show an active or inactive state for each single bit on each module. Provide information accessibility from the program, programming software, or remotely from the OIT.
3. Provide the PLC CPU with light emitting diodes or liquid crystal displays to indicate the health and status of the CPU for the following conditions:
a. Ready Status
b. Run Status
c. Serial Port Activity

d. Local Area Network Status

4. Store the program in either random access memory (RAM) or flash memory. Store all data registers in RAM.
5. Provide the ability to permit data values and program changes while the PLC is operating, without interrupting the overall system process.
6. If the PLC circuit is backed up by a generator, then the PLC shall be backed by an uninterruptible power supply (UPS). A UPS shall provide emergency power between the time utility power is lost and the backup generator begins to provide power. The UPS systems shall be sized to supply power to the PLC equipment, communication modules and switches within the PLC cabinet at full load. UPS systems shall provide status bits to the IPM gold software. These status bits shall indicate if the UPS has faulted and when battery backup power is being used.
7. Furnish the UPS specified in the specifications and DRAWINGS.

I. Communication Services:
1. Provide the PLC with the following capabilities:
a. Modbus TCP Messaging: Provide the web services utilizing Modbus TCP messaging over port 502 of the TCP packet. Protocols reliant on User Datagram Protocol (UDP) are not acceptable.
b. I/O Scanning Service: Provide I/O scanning to allow the PLC to control I/O scanning capable I/O located remotely from the main panel.
c. Faulty Device Replacement (FDR): Act as a faulty device replacement client/server enabling the automatic download of IP address and configuration to FDR client devices.
d. Simple Network Management Protocol (SNMP): Manage the different components through a SNMP connection to monitor network, and device integrity.
e. Global Data: Global data service to ensure real time communication between stations in the same distribution group while minimizing network loading. Provide global data services utilizing Real-Time Publisher Subscriber producer consumer based protocol.
f. Network Time Protocol (NTP) synchronization service: Capable of synchronizing from its internal clock from a reference clock on a NTP server allowing for time stamping internal events.
g. Simple Mail Transfer Protocol (SMTP): Capable of SMTP email transmission service.
h. Bandwidth Monitoring Service: Capable of monitoring the bandwidth to determine load level.

2.2 PLC SOFTWARE:

A. Acceptable PLC Programming Software Tools:
1. Develop all PLC programming application utilizing the version of Schneider Electric EcoStruxure Control Expert currently in use at the City of Phoenix.

Contact the lead City of Phoenix User Tech for the latest version requirements.

2.3 PLC AND OIT PROGRAMMING:

A. Use Black and Veatch Corporation, 2231 East Camelback Rd., Suite 250, Phoenix, AZ 85016, Shawn Rohr rohrsb@bv.com, 602-381-4413 or 602-381-4400 Cell: 623-340-0810, Darrel Nienhueser NienhueserD@bv.com, 602-381-447.

B. General PLC Programs:
1. Develop all PLC programming utilizing function block programming.
2. Generated code for PLCs is the property of the OWNER.
3. All control loops are to function as described in Section 40 61 96 Process Control Descriptions, and as depicted on the CONTRACT DRAWINGS.
4. Enable Unity Pro's grid view feature. Develop the function block applications in a workspace that is 70 columns across by 1230 rows down. Provide the function block workspace with the capability to be printed on standard 8.5 x 11paper.
5. Provide straight lines that are adequately spaced apart with 90 degree turns as necessary for connecting signal wires to function blocks. Limit unnecessary turns or extremely long signal wire runs. Minimize the crossing over, intersecting, and overlapping of all signal wires.
6. Provide a "top down" approach when writing the program functionality. Provide a logical order from the first step of the sequence or process to the last.

C. User Defined Function Blocks (DFB):
1. Develop the programming software to allow the PLC to automatically manage calls and execution to insure proper code execution.
2. Embedded DFBs are prohibited.
3. Provide an internal database using unmapped variables. The variables associated with this block must be separate from the PLC database to prevent mapping conflicts.
4. Provide each block as a single instruction in the programming environment. Designate pin assignments and names for all inputs and outputs. All inputs and outputs required for DFB logic must pass through a pin attached to that DFB. Utilize these pins to connect to the PLC database. DFB's that use serial communications to communicate to non-PLC devices (i.e. a generator) reference this serial communication internally in the DFB without pins.
5. Provide documentation which clearly explains the purpose, function and operation of all DFB's to the OWNER.
6. Provide the OWNER access to modify, copy, edit, delete, and add to all DFB logic.
7. Provide mapping of all I/O (mapped addresses) referenced through the program to unmapped addresses. Provide unmapped addresses for programming logic.

D. PLC and I/O health status:
   1. Provide a programming section that monitors the status of the processor and attached I/O modules.
   2. All PLC's, OIT's, and HMI's require a heartbeat/handshake to provide a communication check.

E. Program Algorithms:
   1. Provide algorithms for various operations including some of the following:
      a. Summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
      b. A 3-mode Proportional-Integral-Derivative (PID) function block which can adjust all three modes independently.
      c. Lead, lag, dead time, and ratio compensators.
      d. Process totalization.
   2. Provide algorithms with the capability of outputting positional or incremental control outputs.
   3. Provide algorithms with alarm checks when appropriate.

F. Naming Convention for Programming Sections:
   1. Provide each programming section with a short descriptive name, including an underscore as a space between words and using mixed case.
   2. The following names are acceptable:
      a. CfgAnalog
      b. Filter_Backwash
   3. The following names are NOT acceptable:
      a. FILTERBACKWASH (all caps)
      b. SectionOne (not descriptive)

G. Programming Sections:
   1. Provide programming sections for PLCs that contain high level logic. Group similar programming function blocks into the same programming section. Multiple sections of the same type are permitted (i.e. a program may have two DI-Mapping sections; DI_Mapping01, DI_Mapping02). The following is a list of major programming sections that are used and the order in which they are to be executed in.
   2. PLC Status
   3. Communication
   4. DI Mapping
   5. AI Mapping/Scaling
   6. Alarms
   7. Process Control Sections
   8. Valve Control Sections
   9. Motor Control Section
   10. Flow Totalization Section
   11. DO Mapping

12. AO Mapping/Scaling

H. Program Addressing:
   1. Verify with The City of Phoenix prior to utilizing the following standards for all programming addressing.
   2. Addressing Scheme

Variable Type	Group Description	Data Type	Address Range
Discrete Inputs / Reads	Physical DI's	T_DIS_IN_GEN	%CH…
	Module Status	T_GEN_MOD	%CH…MOD
	From RTU/Field Device/CCS	EBOOL	%M001 - %M199
	From OIT	EBOOL	%M800 - %M999
Discrete Outputs / Writes	Physical DO's	T_DIS_OUT_GEN	%CH…
	Module Status	T_GEN_MOD	%CH…MOD
	PLC Hardware & Process Alarms	EBOOL	%M200 - %M399
	To RTU/Field Device/CCS	EBOOL	%M400 - %M799
	To OIT	EBOOL	%M1000 - %M1199
	PLC Internal	EBOOL	%M1200 - %M1999
	Other	EBOOL	%M2000 - %M…
Analog Inputs / Reads	Physical AI's	T_ANA_IN_BMX	%CH
	Module Status	T_GEN_MOD	%CH…MOD
	From RTU/Field Device/CCS	WORD	%MW001 - %MW199
	From OIT	INT/UINT/DINT/UDINT	%MW1000 - %MW1199
	From OIT	REAL/OTHER	%MW1200 - %MW1399
Analog Outputs / Writes	Physical AO's	T_ANA_OUT_BMX	%CH
	Module Status	T_GEN_MOD	%CH…MOD
	To RTU/Field Device/CCS	REAL/WORD	%MW200 - %MW999
	PLC Internal	Any	%MW1400 - %MW1999
	To OIT	INT/UINT/DINT/UDI	%MW2000 -

		NT	%MW2199
	To OIT	REAL/OTHER	%MW2200 - %MW2399
	Array Move to %MW Example Reading Registers from Instrumentation or Power Monitoring then Moving to %MW	Any	%MW2400 - %MW…

3. Conform unusual addressing conflicts to the current addressing standard. Submit any unusual addressing conflicts that cannot be resolved to the ENGINEER prior utilization of the address.

I. Analog Scaling;
   1. Scale all hardware analog inputs and outputs to be used internally in the PLC to engineering units (EU). All analog data to be passed to/from the Computer Control System (CCS) shall be passed in the proper data type to maintain the EU without scaling or conversion.

J. Variable/Tag Names:
   1. Derive all input and output names from the tag number assigned on the CONTRACT DRAWINGS. Internal variable names are mixed case. Physical inputs and outputs are upper case. Use underscores instead of dashes to separate portions of the variable names.

K. Commenting:
   1. Provide comments with the function blocks and sections as needed to clarify the intent of the logic. Comments and names are required for each input or output pin of a user Defined DFB.

2.4 OIT SCREENS

A. Provide one of the following Magelis OITs to meet the requirements of the CONTRACT DOCUMENTS. Model numbers do NOT include conformal coating the CONTRACTOR must add this option from the manufacture.
   1. HMI GTO1310
   2. HMI GTO2310
   3. HMI GTO3510
   4. HMI GTO4310
   5. HMI GTO5310
   6. HMI GTO6310
   7. HMI GTO2315
   8. HMI GTO5315
   9. HMI GTO6315

B. Provide a Compact Flash card for uploading and retrieval of historical data logging from the Magelis OIT.
   1. Manufacturer and Part Number:
      a) Modicon, 1GB MPCYN00CF100N

C. Develop OIT screens utilizing the latest version of Vijeo Designer in use at the City of Phoenix. Contact the City of Phoenix User Tech for the latest version in use.

D. Panels Installed Outdoors: Mount OIT's on the inside of the inner cabinet door of the control panel.

E. Animate instruments or devices utilizing a color scheme to indicate its current status. The color red indicates "on", "running", or "open" and green indicates "off" or "closed". Provide text with every color indicating the status the color (i.e. if a button is red then text should overlay the button saying "On", "Running", or "Open").

F. Coordinate OIT screens to resemble existing screens that are in operation with the OWNER, this includes event logging, alarming, trending, fonts, colors, and graphical buttons.

G. Provide a process flow diagram screen with graphics or text as described in the control description. Tabular data is to be reviewed and approved by the OWNER prior to development.

H. Utilize the exported database from the corresponding Unity Pro processor for the tag database.

2.5 NETWORKING

A. General:
   1. Refer to the network drawing as shown on the CONTRACT DRAWINGS.
   2. Provide simplex power receptacles for network devices in a cabinet that requires a power source.

B. Provide all networking hardware as indicated in the DRAWINGS and as specified. Coordinate with the City of Phoenix for the latest models needed.

C. Serial (RS-232, RS-422, and RS-485):
   1. Provide all serial connections as stated per CONTRACT DRAWINGS.
   2. Install in the control panel, all necessary cables and hardware that use serial network topology (i.e. media converters, protocol converters, and properly terminated cabling).

D. Ethernet:
   1. Provide all Ethernet connections as stated per CONTRACT DRAWINGS.
   2. Install in the control panel all necessary cables and hardware that use Ethernet devices.
   3. Provide a DIN rail mounted Cisco Managed Ethernet switch in control panels that have multiple Ethernet devices.
   4. All Ethernet switches are to be managed switches.
   5. Provide protocol and media converters as needed.

E. Fiber:
   1. As shown in the contract DRAWINGS and as specified..

F. REMOTES Radio
   1. As shown in the contract DRAWINGS and as specified.

G. CONTRACTOR shall turn over radio and ethernet switch to OWNER for programming. CONTRACTOR shall install radio and ethernet switch after programming is complete.

H. Contractor to provide RACO Verbatim VSS series Autodialer and shall be equipped with digital alarm input channels as indicated on the P&ID contract drawings. Contractor to provide a Dataremote CDS-9010 cellular backup router as shown in the Drawings and all associated cables for connection to the Autodialer. Contractor shall provide all required cabling per manufacturer's recommendations. The contractor shall program the Autodialer with the messages and phone numbers provided by the Owner. The contractor shall test and verify all alarms with the Owner

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect areas, surfaces, and substrates that enclose PLCs for compliance requirements, installation tolerances, and other conditions affecting performance. Adhere to compliance or tolerance requirements of the manufacturer.

3.2 APPLICATIONS

A. Primary selection of PLCs is based upon OWNER preference followed by I/O, memory, communication, expansion, and other criteria. If multiple PLC panels from different vendors will be supplied, coordinate with other vendors to insure that PLCs are of similar type and are equipped to utilize identical communication networks.

3.3 INSTALLATION

A. Anchor PLCs within enclosures as recommended by the PLC manufacturer.

B. Provide spacing around PLC as required by the PLC manufacturer to insure adequate cooling. Insure that the air surrounding and penetrating the PLC has been conditioned to maintain the required temperature and humidity range of the PLC.

C. Size wires entering and exiting all PLC components and modules to comply with the PLC manufacturers requirements.

D. Blocking or obstructing ventilation slots by any means is not permitted.

E. Install all wiring, wire ducts, or other devices without obstructing the removal of modules from the backplane.

F. Provide accessibility and visibility to all PLC status lights, communication ports, and memory card slots when enclosure door is open.

3.4 IDENTIFICATION:

A. Identify PLC components and wiring according to all applicable codes, standards, and contract document sections.

3.5 FIELD QUALITY CONTROL:

A. Field Service:
   1. Provide a qualified service representative/programmer to perform the following:
   2. Inspect PLCs, wiring, components, connections, and equipment installation.

3. Assist in field testing of equipment. Test and adjust PLCs and associated programs if necessary.

3.6 RECORD DRAWINGS:

A. Maintain a set of red-line panel drawings and CONTRACT DRAWINGS to reflect changes or deviations that occur during installation, start-up, and commissioning. Incorporate these deviations into the final Operation & Maintenance manual.

B. Provide record drawings in accordance with Section 01 78 39 – Project Record Documents.

3.7 SPARE PARTS:

A. Furnish and deliver spare parts and test equipment as outlined in Section 01 78 43– Spare Parts and Maintenance Materials.

B. Pack spare parts in containers bearing labels clearly designating the contents and for which pieces of equipment they are intended for. Store PLCs according to manufacturer's requirements. Minimum storage requires include storage indoors in a clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Additionally, protect PLCs from all forms of electrical and magnetic energy that could reasonably cause damage.

C. The following constitutes the minimum spare parts:
   1. I/O modules: Provide a minimum of one spare of each type of card identified. Provide an additional spare for every card of a specific type installed.
   2. Processors: Provide a minimum of one (1) spare for each type of CPU identified.
   3. PLC oriented power supplies: Provide a minimum of one spare of each type of power supply identified. Provide an additional spare for every power supply of a specific type installed.
   4. Memory Cards:
      a. Memory cards: If an SD memory card is installed then provide a minimum of one spare memory card. For every memory card installed provide an additional spare memory card.
      b. Expandable flash memory cards: If a memory extension card is installed to expand the internal memory of a processor then provide the backup processor with a memory extension card to ensure proper memory size of the backup processor.
   5. Specialty Modules: Provide a minimum of one spare of each type of module identified. Provide an additional spare for every module of a specific type installed.
   6. Backplane: Provide a minimum of one (1) spare backplanes for each type.

3.8 TESTING AND ADJUSTMENTS:

A. Perform system testing and make any adjustments necessary in accordance with this section and Section 40 61 13, Process Control System - General Requirements.

B. Install and test all project generated programming code prior to performing the Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) as stated in Section 40 67 00, Process Control System Panels and Enclosures.

3.9 SOFTWARE DEVELOPER'S SERVICE:

A. Provide a qualified software PROGRAMMER representative to check and approve the installation of all PLCs and components.

B. Provide a qualified representative for installation supervision, start-up, and testing services. Conduct a minimum of five (5) trips to the site to approve the completed installation and to perform start-up testing of the equipment. Coordinate each visit with the ENGINEER prior to arrival on the site. Test the operation of the system in the presence of the ENGINEER and verify that the equipment conforms to the Site Acceptance Test (SAT) document. Revisit the job site as often as necessary until the installation and testing has been signed off by the OWNER or ENGINEER.

C. Provide a qualified software PROGRAMMER representative for operation and maintenance personnel training. Conduct a minimum of five (5) trips to the site to perform the services as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Coordinate each visit with the ENGINEER prior to arrival on the site.

All costs, including travel, lodging, meals, and incidentals for the CONTRACTOR and PROGRAMMER, are considered included in the CONTRACT price.

+ + END OF SECTION + +

SECTION 40 70 00

PROCESS CONTROL SYSTEM PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust, commission and place into satisfactory operation all primary sensors and field instruments furnished under this Section.
   2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

B. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 61 13, Process Control System - General Requirements.

B. Acceptable Manufacturers:
   1. Furnish primary sensors and field instruments by the named manufacturers.
   2. Obtain all sensors and field instruments of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:
   1. Design and manufacture the primary sensors and field instruments in accordance with the applicable general design requirements.
   2. Field supervision, inspection, and start-up in accordance with the requirements of Section 40 61 13, Process Control System - General Requirements.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 40 61 13, Process Control System - General Requirements.

B. Primary sensors and field instruments shall not be delivered to the site until all product information and Shop Drawings for the sensors and instruments have been approved by ENGINEER.

1.4 SUBMITTALS

A. Comply with the requirements specified in Section 40 61 13, Process Control System

- General Requirements.

1.5 CHEMICAL SERVICE

A. Where a primary element is designated for chemical service, all wetted components and appurtenances for that primary element shall be resistant to corrosion by that chemical. Chemicals referred to commonly as "caustic", "sodium hypochlorite", "hydrochloric acid", "ferric chloride", and "methanol" shall mean the following:
   1. "CAUSTIC": Sodium hydroxide (NaOH), 50 percent solution, Specific Gravity = 1.53.
   2. "SODIUM HYPOCHLORITE": Sodium Hypochlorite (NaOCl), 15 percent solution, Specific Gravity = 1.23.
   3. "HYDROCHLORIC ACID": Hydrochloric Acid (HCl), 38 percent solution, Specific Gravity = 1.4.
   4. "FERRIC CHLORIDE": Ferric Chloride (FeCl3), 43 percent solution, Specific Gravity = 1.46.
   5. "POLYMER": Polymer Solution, 0.2 to 0.5 percent solution, Specific Gravity = 1.00.
   6. “METHANOL”: Methanol (CH3OH), 99 percent solution, Specific Gravity = 0.792.

1.6 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

A. Provide the following materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the following list of process fluids:

(The remainder of this page left intentionally blank)

PROCESS FLUID	ELASTOMER	METAL	PLASTIC	OTHER
Air		Type 316 SS	Teflon	
Alum	Buna-N	Type 316 SS		
Ammonia		Type 316 SS	Teflon	
Carbon	Buna-N	Type 316 SS		
Chemical Sump Drainage			Teflon Polypropylene	
Chlorine Gas or Liquid	Viton	Hastelloy C, Monel, or Tantalum		
Digester Gas	Viton	Alloy C276 Type 316 SS		
Ferric Chloride		Tantalum	Teflon Polypropylene	Ceramic
Fluoride	Viton	Hastelloy C		
Glycerine Oil	Neoprene Viton Buna-N	Type 316 SS	Teflon Polypropylene PVC/CPVC	
Halocarbon	Neoprene	Type 316 SS	Teflon	
Hydrochloric Acid	Viton	Tantalum Zirconium Platinum	Teflon	Ceramic
Lime		Type 316 SS	Teflon	
Methanol		Type 316 SS	Teflon	
Non Potable Water	Neoprene	Type 316 SS	Teflon	Ceramic
Odor Control Scrubber Solution		Platinum	Teflon Tefzel	Ceramic

PROCESS FLUID	ELASTOMER	METAL	PLASTIC	OTHER
Polymer	Buna-N	Type 316 SS		
Potassium Permanganate	Viton	Carpenter 20		
Raw Sewage	Viton	Type 316 SS	PTFE Polypropylene	
Sodium Chloride			Teflon	
Sodium Hydroxide		Hastelloy B Zirconium Platinum	Teflon Polypropylene PVC/CPVC	Ceramic
Sodium Hypochlorite		Hastelloy C Tantalum Titanium Platinum	Teflon PVC/CPVC Kynar	Ceramic
Silicone Oil	Viton Buna-N	Type 316 SS	Teflon Polypropylene	
Sludge	Neoprene Buna-N	Type 316 SS	PTFE	Ceramic

1.7 IDENTIFICATION TAGS

A. All sensors and field instruments shall have an identification tag conforming to the following requirements:
   1. Provide CMMS Tags for all instruments as specified under Section 01 93 13.15, Computerized Maintenance Management System Tags.

1.8 SUNSHADES

A. Instruments and analyzers installed outdoors shall be firmly supported and protected by sun / rain shades, as specified or shown on DRAWINGS.
   1. Product and Manufacturer: Provide one of the following:
      a. Obrien – VIPAK
      b. Alumaline
      c. Or Equal

PART 2 - PRODUCTS

2.1 PROCESS TAPS, SENSING LINES AND ACCESSORIES

A. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:
   1. Material: Type 316 stainless steel; .049 wall thickness.
   2. Pressure Rating: 250 psi.

3. Size: 1/2-inch outside diameter or as shown on the Drawings.
4. Connections: Type 316 stainless steel compression type, "Swagelok", as manufactured by Crawford.
5. Shut-off Valves:
   a. Type: Full port ball.
   b. Pressure Rating: 250 psi.
   c. Body, Ball and Stem: Type 316 stainless steel.
   d. Packing: High Density TFE.
   e. Handle: Nylon with metal travel stops.
   f. Support Rings: Stainless steel.
   g. End Connections: Removable "Swageloks".
   h. Product and Manufacturer: Provide one of the following:
      1) 45 Series, as manufactured by Whitey.
6. Manifolds:
   a. Type: Five valve and three valve meter manifolds.
   b. Materials: Type 316 stainless steel body, bonnets and stems, delrin seats, Teflon packing.
   c. Product and Manufacturer: Provide one of the following:
      1) Whitey.
      2) Anderson-Greenwood

B. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters:
   1. Material: Type 316 stainless steel tubing, ASTM A 269, .049 wall thickness.
   2. Pressure Rating: 250 psi.
   3. Size: 1/2-inch outside diameter or as shown on the Drawings.
   4. Connections: Type 316 stainless steel compression type, "Swagelok" as manufactured by Crawford.
   5. Shut-off Valves:
      a. Type: Full port ball.
      b. Pressure Rating: 250 psi.
      c. Body, Ball and Stem: Type 316 stainless steel.
      d. Packing: High density TFE.
      e. Handle: Nylon with metal travel stops.
      f. Support Rings: Stainless steel.
      g. End Connections: Removable "Swageloks"
      h. Product and Manufacturer: Provide one of the following:
         1) 43 Series, as manufactured by Whitey.
   6. Manifolds:
      a. Type: Five valve and three valve meter manifolds.
      b. Materials: Type 316 stainless steel body, bonnets and stems, delrin seats, teflon packing.
      c. Product and Manufacturer: Provide one of the following:
         1) Whitey.

C. Pressure Tap Sensing Lines and Accessories for Pressure Gages and Pressure Switches:
   1. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
      a. Material and Fittings: Type 316 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403) in accordance with Section

33 05 23, Stainless Steel Pipe.

b. Sizes: ½-inch minimum for main sensing piping and ¼-inch gage and switch connections or as shown on the Drawings.

c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 33 14 10, Piping Systems.

d. Accessories:

1) For applications not requiring diaphragm seals, provide separate ¼-inch Type 316 stainless steel threaded gage cocks for each gage and switch.

2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff for each gage and switch. Ball valves shall be provided in accordance with the requirements of Section 40 05 63, Ball Valves, Operators and Appurtenances.

2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:

a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Copper pipe and fittings shall be provided in accordance with the requirements of Section 33 05 17, Copper Pipe. CPVC pipe and fittings shall be provided in accordance with the requirements of Section 33 05 31, Thermoplastic Pipe.

b. Sizes: 1/2-inch minimum for main process sensing piping and for gage and switch connections.

c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 33 14 10, Piping Systems.

d. Accessories:

1) For copper piping system taps with or without seals, provide a separate ¼-inch minimum threaded brass or bronze gage cock for each gage and switch.

2) For CPVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded ball valve for process sensing line shutoff for each gage and switch. Ball valves shall be provided in accordance with the requirements of Section 40 05 66, Thermoplastic Valves, Operators and Appurtenances.

2.2 INSTRUMENTATION

INSTRUMENT TYPE F1 - MAGNETIC FLOWTUBE AND TRANSMITTER

A. Functions:

1. Flowtube: Produce low level, high impedance pulsed DC signal proportional to the rate of fluid flow using the principle of electromagnetic induction.
2. Pulsed DC Magnetic Flow Transmitter: Drive the flowtube coils with pulsed DC power and convert the flowtube output signal into a DC current output linear to the flow rate.

B. System (Flowtube and Transmitter) Performance Requirements:

1. System Accuracy (with Analog Output): ±0.5 percent of flow rate or better over range from 1 fps to 31 fps; ±.005 fps or better at flows below 1 fps flow range. System accuracy shall be proven by submittal of flow test curves of the actual

meters being furnished. Test curves shall show a minimum of three flow points. Tests shall be performed using water and a weight or volume tank. A "Master Meter" used, as a reference standard is not acceptable. The test setup shall be submitted and approved prior to testing.

2. System Repeatability: ±0.15 percent of flow rate or ±.0015 fps, whichever is greater.
3. Drift: Complete zero stability.
4. Minimum Fluid Conductivity Limit: Five microsiemens per centimeter or less.
5. Fluid Property Effects: Accuracy unaffected by changes in fluid velocity, density, pressure, temperature or conductivity (above minimum conductivity limits).

C. Transmitter:
   1. Output: 4 to 20 mADC, direct acting and isolated, into 0 to 700 ohms.
   2. High accuracy, field adjustable scaled pulse output (2 to 800 Hz or greater) to drive local totalizer and provide scaled pulse output with a durations width of 0.5ms to 2 sec.
   3. Power Consumption: Not to exceed 50 watts for flowtube and transmitter combined.
   4. Operating Temperature: Suitable for operation with process fluid temperature from 0 to 140°F.
   5. Interchangeability: Ratio of flow velocity to voltage reference signals generated identical for all meter sizes to permit interchangeability with transmitter without requiring circuit modifications.
   6. Solid state construction.
   7. Pulse and analog outputs galvanically isolated from input and earth ground.
   8. Automatic zeroing feature making it unnecessary to zero the instrument before or after placing it in operation.
   9. Precalibrated span adjustment providing continuous span adjustment over entire range. Range adjustment: Integral pushbuttons continuously adjustable for full-scale settings from 1 to 31 feet per second.
   10. Signal Conditioning: Adjustable damping circuit with response times of 1 to 25 seconds minimum.
   11. Low Flow Cutoff: Provide automatic low flow cutoff circuitry to stop pulse output and local totalization when flow drops below 0.5 percent ±0.2 percent of the calibrated upper range valve.
   12. Enclosure:
       a. Die cast, low-copper aluminum alloy, NEMA 4.
       b. Finish: Epoxy coating.
   13. Mounting:
       a. All transmitter and driver electronics shall be remotely mounted from the flow tubes at locations shown on the Drawings.
       b. Provide complete Type 316 stainless steel mounting hardware.
       c. Type of mounting (wall, support frame or pipe stand), as required.

   14. Local Indication:
       a. 3-1/2 digit minimum LCD meter with field selectable engineering units; or analog multi-meter with linear 0 to 100 percent scale for flow rate indication. The engineering units shall be as specified in the Instrument List.

b. 7-digit electromechanical totalizer or 8 digit electronic LCD totalizer with reset and lithium battery backup. Count scaling shall be as specified in the Instrument List. Totalizer shall be integral with transmitter and visible through viewing window, or shall be externally mounted in a separate NEMA 4X enclosure or condulet with viewing window and installed adjacent to the transmitter.

15. Power Requirements: Designed for operation on 120 VAC ± ten percent, 60 Hz, ±3 Hz power supply.
16. Provide shielded cable assemblies of sufficient length to met mounting locations as shown on DRAWINGS for connection between flowtube and transmitter electronics.
    a. Protect magnetic flow meter transmitter to flowtube shield cable from the sun and weather.

D. Construction and Required Features:
1. Flowtube:
    a. Type: Lined metal flowtubes.
    b. Liner Material: PFTE.
2. Tube Material:
    a. Meter tubes 12-inch and smaller: Type 304 stainless steel.
    b. Metering tubes 14-inch and larger: Type 304 stainless steel, .125-inch wall thickness.
3. Pressure Rating: Greater than or equal to test pressure specified in Section 33 14 10, Piping Systems, for appropriate piping system.
4. Electrodes:
    a. Conical or elliptical shaped.
5. Enclosure:
    a. Materials and Rating: Cast low-copper aluminum alloy or fabricated sheet steel, NEMA 6 rated.
    b. Finish: Finish exterior, except for flange faces, with a high build epoxy paint.
6. Electrical Connections: 1/2 inch minimum to 3/4-inch maximum NPT tapped holes for power conduit fitting and signal conduit fittings.
7. Type 316 stainless steel grounding rings for flowtubes.
8. Type 316 stainless steel grounding straps.

E. Provide one calibrator suitable to calibrate all flow tubes provided.

F. Product and Manufacturer: Provide one of the following:
1. Endress + Hauser Promag W Series with Model 53 Signal Converter (City Preferred).
2. Krohne America Incorporated Enviromag KC with Model 300 Signal Converter.
3. ABB/Fischer and Porter Magmaster MFE/MFF.

INSTRUMENT TYPE FS2 - FLOW INDICATING SWITCH – SWINGING VANE TYPE

A. The flow-indicating switch shall be swinging vane suitable for the applications shown on the Drawings. For seal water service, coordinate with requirements of equipment being furnished.
B. Required Features:

1. NEMA 4X housing and control box.
2. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
3. Line size and connection ends as shown on the Drawings.
4. Dual switches, each SPDT, minimum rating five amps at 120 VAC.
5. Field adjustable switch setting.
6. Switch accuracy and deadband shall be five percent of full range.

C. Product and Manufacturer: Provide one of the following:
1. PEECO
2. W. E. Anderson
3. Or Equal

INSTRUMENT TYPE L1 - LEVEL TRANSMITTER – ULTRASONIC TYPE

A. Type: Non-contact system using transducer to convert electrical pulses from the transmitter into sonic pulses directed towards the metered surface and receives the reflected sonic pulses and converts them back into electrical pulses for reception by the transmitter. Transmitter shall generate and time the electrical pulses, and count and convert the pulse travel times into an analog output signal linearly proportional to level/flow.

B. System Performance Requirements:
1. Accuracy: Not less than ± 0.25 percent of full-scale range.
2. Linearity and Repeatability: Not less than ±1 percent of full scale.
3. Resolution shall be 0.1 percent of range of 2mm (0.08”) whichever is grater.
4. Minimum Operating Distance from Transducer (Deadband): 12-inches.
5. Beam Pattern: As recommended by the manufacturer..
6. Transmitter Outputs: Provide each of the following:
   a. 4 to 20 mADC, direct acting and isolated, signal proportional to level, into 0 to 750 ohms.
   b. Minimum of six (6) independently adjustable alarm setpoint, relays outputs rated at five amps, 250 VAC non-inductive.
   c. Loss of echo relay, which energizes when measured level falls beyond signal range or signal, is interrupted for any other reason. Relay output shall be rated five amps 250 VAC non-inductive.
7. Environmental Conditions: Suitable for use under the environmental conditions specified in Section 40 61 13, Process Control System - General Requirements.
8. Power Consumption: 25 watts, maximum.
9. Temperature Compensation: Range – 58 to 302ºF, integral temperature sensor in transducer.

C. Required Features:
1. Transducer:
   a. Encapsulated by a corrosion resistant and submergence resistant material: PVDF.
   b. Class, division, and group as applicable for this project.
   c. Designed for suspended PVC coated galvanized rigid steel conduit mounting or equipped with ANSI 150 pound flanges for flange mounting.

d. 1-inch external NPT PVC coated galvanized rigid steel conduit connection.

2. Transmitter:
   a. Solid state construction.
   b. Built-in digital filtering for EMI protection and external acoustical noise rejection.
   c. Built-in automatic compensation for variations in temperature, pressure and density of the sonic signal medium.
   d. LCD indicator scaled in engineering units for the range required.
   e. Software adjustable zero and span adjustment over 0 to 100 percent of the calibrated range.
   f. Lost Echo and Power On Lights.
   g. Housed in weatherproof, splash proof and corrosion resistant NEMA 4X enclosure and suitable wall or pipe stand mounting. Provide with a transparent window to permit viewing indicating meter and lights.
   h. Internally mounted diagnostic LED's to allow isolation of faults in terms of major components.
   i. Designed for operation on 120 VAC ±10 percent, 60 Hz power supply.
3. Accessories:
   a. Transducer cables 2-3 copper conductors, twisted with shield and drain wire, the actual length required, for connection between the transducer and transmitter
   b. One Hand held calibrator

D. Product and Manufacturer: Provide the following:
   1. HydroRanger with EchoMax Transducer Model XRS-5 for Class 1, Division 2, EchoMax Transducer Model XPS-15 for Class 1, Division 1 (Wetwells) and Model ST-H for chemical storage tanks, as manufactured by Siemens.

INSTRUMENT TYPE N1 - STROBE LIGHT/HORN

A. General: Strobe light with horn shall be a pulsating, illuminating, multi-tone audible device providing warning in an area where a potential hazard may occur. A strobe light without horn shall provide warning at entrances to aforementioned area.

B. Service: Indoors (wet atmosphere)/Outdoors/Hazardous Area.

C. Required Features:
   1. Power Required: 120 VAC, 60 Hz.
   2. Strobe Light: Minimum 250 candlepower; 360-degree pattern.
   3. Flashing Mechanism: 72 to 75 flashes per minute.
   4. Dome Material of Construction: Polycarbonate.
   5. Color: Amber/Red/Blue.
   6. Base Materials of Construction: Aluminum (NEMA 4X Rated)/Cast Aluminum (NEMA 7 Rated).
   7. Mounting: Wall/Ceiling: Provide appropriate brackets and appurtenances.
   8. Decibel Output: 100 at ten feet minimum with manual volume control.
   9. Provide 12 by 18-inch safety sign with each strobe light.

D. Product and Manufacturer: Provide one of the following:
   1. NEMA 4X Rated: 400 ST/350 as manufactured by Federal Signal.

INSTRUMENT TYPE P1 – DIFFERENTIAL PRESSURE TRANSMITTER

A. Type: Two-wire, differential capacitance or resonant type transmitter.

B. Required Features and Accessories:
1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ±0.075 percent of calibrated span..
2. Stability (drift over a six month period): Not more than ±0.25 percent of transmitter upper range limit.
3. Ambient Temperature Effect: Total Error per 100°F change between the limits of -20°F and +180°F: Not more than ±1.0 percent of the transmitter upper range limit (maximum span).
4. Supply Voltage Effect: Output change not greater than 0.005 percent of span for each one-volt change in supply voltage.
5. Output:
   a. Isolated direct acting 4 to 20 mADC.
   b. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.
6. Solid state electronic components.
7. Positive overrange protection of at least 1.25 times the maximum span limit.
8. Calibration Adjustments:
a. Zero: Adjustable in electronics compartment.
b. Span: Course and fine span adjustments in electronics compartment.
9. Zero elevation and suppression capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
10. Adjustable internal damping.
11. Measuring elements protected by sealing diaphragm.
12. Built-in electrical surge and RFI protection.
13. Integral square root extraction providing linear 4 to 20 mADC output proportional to flow when required.
14. Electric Conduit Connection: 1/2-inch NPT.
15. Process Connections: 1/2-inch NPT.
16. Designated to operate on power from receiver or remote power supply, nominal 24 VDC.
17. Type 316 stainless steel mounting bracket and hardware suitable for mounting transmitter on flat vertical surface or 2-inch diameter pipe.
18. Non-Wetted Parts:
   a. Body and Process Connection Bolting: Type 316 stainless steel.
   b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers shall be threaded and seated on Buna-N O-rings; NEMA 4 rating.
   c. Capsule Fill Liquid: Silicone oil except for Chlorine and Fluoride Systems. For Chlorine and Fluoride Systems use Flurolube Oil.
19. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
20. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.

21. Remote Pressure Diaphragm Seals:
    a. Size and Type: 3-inch ANSI Class 150 flanged with flush diaphragm.
    b. Quantity: One or two as required by application.
    c. Diaphragm Seal Housing, Flanges and Bolting (non-process wetted) Materials: Type 316 stainless steel.
    d. Capillary Tubing:
        1) Material: Armored Type 316 stainless steel.
        2) Length: As required to extend from remote seal to transmitter (five feet minimum; 25 feet maximum).
    e. Fill Fluids:
        1) Remote Seal and Capillary: DC 200 silicone oil.
22. Indicator: Provide integral indicator in engineering units.
23. Hazardous Area Requirements: Where so required, provide transmitters rated for use in Class I, Group D, Division 1 hazardous areas.
24. Hand held interface with keyboard and LED display capable of easily configuring and testing the transmitter.

C. Product and Manufacturers: Provide one of the following:
    1. Yokogawa.
    2. Rosemount, Incorporated.
    3. Honeywell

INSTRUMENT TYPE P3 - PRESSURE GAUGE

A. Bourdon Tube Pressure Element Type, Liquid Filled Gage (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):
    1. Performance Requirements:
        a. Accuracy: ±0.5 percent of span (ANSI B40.1 Grade 2A).
    2. Construction Features:
        a. Case:
            1) Solid front design constructed of glass filled polyester.
            2) Color: Black.
        b. Ring: Threaded, glass filled polyester.
        c. Full blowout back.
        d. Window: Glass.
        e. Dial: White with black marking; 270-degree scale.
        f. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
        g. Movement: Cam and roller movement, 300 Series stainless steel.
        h. Size: 4-1/2-inch.
        i. Connection: 1/4-inch male NPT back or bottom, as required.
        j. Mounting: Stem, flush panel or wall mounting, as required.
        k. Adjustable pointer.
        l. Built-in overload and underload movement stops.
        m. Pressure Snubber: Sintered Type 316 stainless steel snubber threaded into gage socket or in external stainless steel housing with 1/4-inch NPT male and female connections.
    3. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.

4. Gauge Filling Liquid: Silicone Oil

B. Product and Manufacturer: Provide one of the following:
1. Helicoid.
2. 3D Instruments, Inc.
3. Ashcroft.
4. Or Equal

INSTRUMENT TYPE P4 - PRESSURE INDICATING TRANSMITTER

A. Type: Two-wire, capacitance type, direct mount gage pressure indicating transmitter with single seal or closed coupled diaphragm seal.

B. Required Features and Accessories:
1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ±0.075 percent of calibrated span.
2. Stability (drift over a six month period): Not more than ±0.25 percent of transmitter's upper range limit.
3. Ambient Temperature Effect: Total Error per 100°F change between the limits of -20°F and +180°F: Not more than ±1.0 percent of the transmitter upper range limit (maximum span).
4. Supply Voltage Effect: Output change not greater than 0.005 percent of span for each one-volt change in supply voltage.
5. Output:
a. Isolated direct acting 4 to 20 mADC, Plus Hart digital signal
b. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.
c. Zero and span adjustments
d. Damping adjustable 0 to 10 seconds.
6. Solid state electronic components.
7. Positive over range protection of at least 1.25 times the maximum span limit.
8. Calibration Adjustments:
a. Zero: Adjustable in electronics compartment.
b. Span: Course and fine span adjustments in electronics compartment.
c. Rangeability - Turndown ratio to provide a variable programmable range span.
d. User selected linear or integral square root extraction providing linear 4 to 20 mADC output proportional to flow when required.
9. Zero elevation and suppression capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
10. Built-in electrical surge and RFI protection.
11. Electrical Connection ½" – NPT
12. When instrument is installed below grade in a valve vault use a submersible type transmitter only. Provide 24VDC pressure indicator readout above grade
13. Power Requirements: 24 VDC (Operates on 10.5 to 55 Volts DC)
14. Process Connection: 2" up to the diphragm seals.
15. Non-Wetted Parts:
a. Body and Process Connection Bolting: Type 316 stainless steel.
b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers shall be threaded and seated on Buna-N O-

rings; NEMA 4 / 6P rating.

c. Capsule Fill Liquid: Silicone oil except for Chlorine and Fluoride Systems.

16. Material: All wetted parts to be 316 stainless steel or hastiloy C based on process fluid being measured.
17. Software Functionality
    a. Transmitter shall be capable of digital communications over the 4 to 20mA output loop without interruption using the Hart Protocol.
    b. Transmitter shall perform continuous diagnostics, be capable of self-test functions, and be able to give specific diagnostic information.
    c. Configuration capabilities shall allow the user the ability to input and store information including range, engineering units, damping, spare root or linear output, date, message descriptor, and tag number.
18. Indicator: Provide integral indicator in engineering units when the transmitter is readily accessible.
19. Area Requirements: Provide transmitters rated for use in Class I, Division 2 hazardous areas.
20. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.
21. Provide one hand held interface with keyboard and LED display capable of easily configuring and testing the transmitter.

C. Product and Manufacturers: Provide one of the following:
1. Model EJX530A as manufactured by Yokogawa
2. Model 2051TG as manufactured by Rosemount
3. Model YSTR14G as manufactured by Honeywell
4. Model PMC71 as manufactured by Endress Hauser

INSTRUMENT TYPE P5 - PRESSURE INDICATING TRANSMITTER - CERAMIC FLUSH MOUNTED DIAPHRAGM (FOR SEWAGE LIFT STATIONS)

A. Type: Two-wire, capacitance type, direct mount gage ceramic diaphragm flush mounted pressure indicating transmitter.

B. Required Features and Accessories:
1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ±0.1 percent of calibrated span.
2. Stability (drift over a six month period): Not more than ±0.1 percent of transmitter's upper range limit.
3. Ambient Temperature Effect: Total Error per 100°F change between the limits of -20°F and +180°F: Not more than ±1.0 percent of the transmitter u upper range limit (maximum span).
4. Hysteresis is less than or equal to .02% of full scale.
5. Supply Voltage Effect: Less than or equal to 0.1% of full scale per 10 volt change
6. Output:
    a. Isolated direct acting 4 to 20 mADC, Plus Hart digital signal
    b. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.

c. Zero and span adjustments by internal keys or Hart Communicator
d. Damping adjustable 0 to 25 seconds minimum.

7. Solid state electronic components.
8. Positive over range protection of at least 1.25 times the maximum span limit.
9. Calibration Adjustments:

a. Zero: Adjustable in electronics compartment.
b. Span: Course and fine span adjustments in electronics compartment.
c. Process Range - 0 PSI to 200 PSI
    1) The measurement range can be set up from keys/buttons on the pressure transmitter, or HART communicator
    2) Start and end of measurement range can be continuously adjusted within the nominal range.

10. Zero elevation and suppression capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
11. Built-in electrical surge and RFI protection.
12. Electrical Connection ½" – NPT with side cover
13. Supply Voltage: 24 VDC - Tranmitter operations between 11.5 to 36 Volts DC.
14. Process Connection: Threaded ANSI MNPT 1-1/2" 316L flush mount into a saddle tap or weld-a-let fitting.
15. Non-Wetted Parts:
    a. Body: Type 316 stainless steel.
    b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers shall be threaded and seated on Buna-N O-rings; NEMA 4/6P (IP66/67) rating.
16. Sensor: The ceramic sensor is a dry "no oil fill required" sensor in contact with process fluid wastewater being measured.
17. Software Functionality
    a. Transmitter shall be capable of digital communications over the 4 to 20mA output loop without interruption using the Hart Protocol.
    b. Transmitter shall perform continuous diagnostics, be capable of self-test functions, and be able to give specific diagnostic information such as measurement error, out of range measurement output signal on error
    c. Configuration capabilities shall allow the user the ability to input and store information including range, engineering units, damping, output signal , message descriptor, and tag number.
18. Seal: FPM Viton
19. Hazardous Area Requirements: FM Class I, Division 2, Groups A-D
20. Provide LCD display. Display Units in PSI. Display capable of showing indication of over range or error
21. Bursting Pressure for all ranges: 1,000 PSI
22. Storage temperature -40 to +120 degrees centigrade

C. Product and Manufacturer:
    1. Endress Hauser PMC71-RBCP62DAAA

INSTRUMENT TYPE PE1 - DIAPHRAGM SEAL

A. General: Furnish diaphragm seals for pressure gages, pressure switches and pressure transmitters at locations shown on the Drawings and as specified.

B. Required Features:
   1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
   2. Instrument Connection: Coordinate size with instrument NPT-
   3. Process Connection: 1/2-inch NPT.
   4. Working Pressure Rating: Equal to or greater than the attached gage or switch operating pressure specified in Section 33 14 10, Piping Systems, whichever is greater.
   5. Filling Fluid:
      a. Silicone.
      b. For Chlorine or Fluoride systems: Halocarbon or Flurolube Oil.
   6. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
      a. 1/4-inch NPT flushing connection.

C. Construction Features:
   1. Top Housing:
      a. Type 316 stainless steel.
      b. For Chlorine gas or liquid: Hastelloy C, Monel, or Tantalum.
   2. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.

D. Assembly and Calibration:
   1. The complete diaphragm seal assembly, including gage, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch setpoints specified prior to shipment.
   2. System Supplier shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage, switch or transmitter accuracy over the specified measurement range or at switch setpoints.
   3. Location and orientation of the gages, switches and seal assemblies shall be coordinated with the actual piping and equipment installations so that gages and indicators shall be easily read and accessed for maintenance by plant personnel.
   4. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled and re-calibrated as directed by ENGINEER.

E. Product and Manufacturer: Provide one of the following:
   1. Ametek/Mansfield & Green (for low pressures).
   2. Emerson/Helicoid.
   3. Ashcroft.

INSTRUMENT TYPE PS1 - PRESSURE SWITCH

A. Type: Switch assembly with diaphragm piston actuator for sensing gage or differential pressure.

B. Performance Specifications:
   1. Setpoint Accuracy: ± One percent of span.
   2. Adjustable Deadband Range and Setting:
      a. Maximum full scale, minimum seven percent of full scale.
      b. Required Deadband Setting: As required.
   3. Switch: Snap action, SPDT rated not less than five amp resistive at 120 VAC and 1/2 amp resistive at 125 VDC. Provide DPDT contacts and other optional switch configurations when so required.
   4. Switch and Reset (Deadband) Action: Adjustable, Fixed, Manual Reset or Two Stage type.

C. Construction Features:
   1. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
   2. Set and Reset Point Adjustments: Adjustable external adjusting nuts and pressure setting scales.
   3. Process Connection: 1/2-inch NPT.
   4. Housing: Copper-free die cast aluminum, NEMA 4; NEMA 7 construction required for hazardous areas.
   5. External Mounting Lugs.
   6. Adjusting Nuts Metal Cover with Gasket on NEMA 4 and NEMA 7 rated units.
   7. Electrical Connection: 3/4-inch NPT.

D. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.

E. Product Manufacturer: Provide pressure switch of one of the following:
   1. Ashcroft.
   2. United Electric Controls, Model.
   3. Barksdale.
   4. Dwyer Model.

INSTRUMENT TYPE PS2 - DIFFERENTIAL PRESSURE SWITCH

A. General: The differential pressure switch shall be capable of sensing pressure from two sources and, when their difference reaches a preset value, close or open sets of unpowered contacts capable of passing five amps at 120 VAC minimum.

B. Required Features:
   1. NEMA 4X housing; except in hazardous areas, provide explosion proof (NEMA 7).
   2. Covered (NEMA 4) terminal strip.
   3. Slack diaphragm type.
   4. Switch body and diaphragm shall be capable of sustaining 100 percent pressure reversal throughout its range.
   5. Pressure Connection: 1/8-inch NPT internal thread.
   6. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.

C. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.

D. Product and Manufacturer: Provide one of the following:
   1. United Electric Controls.
   2. Dwyer.

INSTRUMENT TYPE T1 - TEMPERATURE SENSOR AND TRANSMITTER - RTD TYPE

A. Sensor Requirements:
   1. Accuracy: Plus or minus 0.5°F or plus or minus 0.5 percent of actual temperature, whichever is greater from 32°F to 1200°F.
   2. Stability: Less than ±0.1°F shift from initial calibration in one year.
   3. Resistance: 100 ohms at 32°F.
   4. Resistance Change: 0.22 ohms per degree.
   5. Sensor Assembly:
      a. Platinum RTD type sensor assembly consisting of the following components:
         1) Three lead wire type RTD with primary resistance wire wound in a coil.
         2) No. 22 AWG minimum insulated leads and resistance wire enclosed in small diameter seamless, closed end sheath.
         3) Sheath surrounded by a thermowell designed for threaded, flanged or welded process mounting as required.
         4) Element, sheath and thermowell joined to an industrial, heavy-duty, waterproof type head using extension fittings; compression springs and pressure plate to maintain RTD tip contact with end of thermowell.
            a) Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured
            b) Insertion Length: Coordinate lengths with process piping and installation requirements.
            c) Three lead extension wire between connection head and transmitter of shielded, armored or waterproof type as recommended by the manufacturer.
            d) RTD assembly shall be of the spring-loaded design. NEMA 4X connection head shall be furnished with threaded cover and O-ring gasket.

B. Transmitter Requirements:
   1. Accuracy: Plus or minus 0.2 percent of calibrated span, including repeatability, hysteresis, linearity and adjustment resolution. (Not including sensor error).
   2. Output: 4 to 20 mADC linear with temperature. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.
   3. Ambient Temperature Limits: -40°F to 185°F.
   4. Ambient Temperature Effect: Not more than plus or minus 0.03 percent of reading. Change in calibrated span for a 50°F change in ambient temperature within operative limits.
   5. Power Supply Effect: Maximum of plus or minus 0.005 percent of span per one

volt change in power supply.
6. Solid-state electronics.
7. Input/output isolation.
8. Factory calibrated for the operating temperature ranges required.
9. Field adjustable span and zero settings.
10. Built-in EMI and RFI protection.
11. Electronics housing designed and constructed to meet NEMA 4X requirements and equipped with brackets suitable for pipe stand mounting remote from the RTD Sensor assembly.
12. Barrier terminal strip wiring connections.
13. 3/4-inch internal NPT conduit connections.
14. Designed to operate from remote power supply at 12 to 45 VDC.

C. Accessories:
1. Provide a local loop powered 0 to 100 percent analog or 3-1/2 digit LCD indicator mounted either in the transmitter enclosure and visible through an inspection window, or mounted in a separate enclosure installed near the transmitter. LCD indicator shall be calibrated in engineering units and shall have an accuracy of plus or minus 0.1 percent of span and plus or minus one count. Analog meter shall have an accuracy of ± two percent and shall be furnished with an auxiliary stainless steel tag to indicate 0 to 100 percent calibrated range in engineering units.

D. Product and Manufacturer: Provide one of the following:
1. Sensors:
a. Honeywell.
b. Rosemount, Incorporated.
c. Yokogawa.
2. Transmitters:
a. Series STT 3000, as manufactured by Honeywell.
b. Series 3144, as manufactured by Rosemount, Incorporated.
c. Series, YTA, as manufactured by Yokogawa.

INSTRUMENT TYPE LS2 - LEVEL SWITCH - FLOAT TYPE

A. General: The device shall be capable of detecting fluid level and initiating a signal.

B. Type: Direct acting float.

C. Required Features:
1. Sealed SPDT control switch (non-mercury), actuation by steel ball.
2. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
3. Heavy duty, flexible 18 gauge, three connector, PVC cable with waterproof connection. Cable length, as required.
4. Not sensitive to rotation.
5. Operating Temperature: Up to 140°F.
6. Provide cable weight or mounting bracket to suit installation.

D. Product and Manufacturer: Provide the following:
   1. ITT/Flygt, Model ENM-10.
   2. Or Equal

INSTRUMENT TYPE PS4 - DIFFERENTIAL PRESSURE INDICATING SWITCH

A. General: Differential pressure switch shall be capable of sensing pressure from two sources and, when their difference reaches a preset value, close or open sets of unpowered contacts.

B. Required Features:
   1. NEMA 4X housing
   2. Covered terminal strip.
   3. Slack diaphragm type.
   4. Switch body and diaphragm shall be capable of sustaining 100 percent pressure reversal throughout its range.
   5. Pressure Connection: 1/8-inch NPT internal thread.
   6. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
   7. Switch: Snap action, SPDT rated not less than five amp resistive at 120 VAC and 1/2 amp resistive at 125 VDC. Provide DPDT contacts and other optional switch configurations, when so required.
   8. Indicator:
      a. Type: 2-1/2-inch diameter.
      b. Display: 90 percent scale, white face, black numerals.
      c. Accuracy: 1.5 percent mid-range, three percent at ends.

C. Product and Manufacturer: Provide one of the following:
   1. United Electric.
   2. Or Equal

1.3 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, all of which shall be identical and interchangeable with similar parts furnished under this Section. Comply with the requirements of Section 01 78 43, Spare Parts and Maintenance Materials.

B. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Minimum spare parts: As recommended by the Manufacturers.

D. The following shall constitute the minimum test and calibration equipment.
   1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors.
   2. All special calibration equipment required for system calibration.

E. All spare parts shall have been operated and tested in the factory as part of factory

testing prior to shipment of the control system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the CONTRACT DOCUMENTS. Transmitters and instruments require access for periodic calibration or maintenance. Transmitters and instruments shall be mounted so they are accessible while standing on the floor.

C. All items shall be mounted and anchored using Type 316 stainless steel hardware, unless otherwise noted.

D. All field instruments shall be rigidly secured to walls, stands or brackets, as required, by the manufacturer and as shown on the Drawings. Mounting instruments on handrails will not be allowed.

E. Conform to all applicable provisions of the NEMA and NFPA standards, local, state and federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, AND TESTING AND TRAINING

A. Comply with the requirements of Section 40 61 13, Process Control System - General Requirements.

B. Calibration of Instruments:
   1. All instruments are to be field calibrated and witnessed by the ENGINEER through their entire range or with the required setpoints based on the requirements stated in Specification 40 06 70 Schedules of Instrumentation for Process Systems prior to start-up. Factory calibrated instruments are required to be recalibrated in the field prior to start-up and witnessed by the ENGINEER. Utilized form 40 61 13-B - Calibration Test Data Form as provided in Specification 01 33 10– Reference Forms to document the field calibration.

C. Primary Sensors/Transducers and Field Instruments:
   1. Provide on-site operation and maintenance training by EQUIPMENT SUPPLIERS and/or the EQUIPMENT MANUFACTURER REPRESENTATIVES prior to placing the equipment in continuous operation, conforming to the requirements of Section 01 79 00, Instruction of Operations and Maintenance Personnel. The services of equipment manufacturer's representatives shall be provided for a minimum of two (2) hours for each type of the instrument.

   2. Training shall accomplish the following:
      1) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance and equipment calibration.

+ + END OF SECTION + +

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SECTION 40 97 00

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals required to furnish and install variable frequency drives (VFD), complete and operational with controls and accessories as shown on the Drawings and as specified. Type 316 stainless steel anchor bolts shall be included and shall be furnished in this Section.

B. Coordination: Coordinate speed control, starting and acceleration torque requirements with the driven equipment. Submit an acceptance letter from the driven equipment and motor manufacturers stating that each VFD will fully meet all starting and operating requirements of the respective driven equipment/motor combination. Responsibility belongs to CONTRACTOR for coordinating all VFD units with the driven equipment to obtain successful operation throughout the driven equipment speed range.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years' experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years. Prototypes or newly introduced drive unit models will not be acceptable.

B. The manufacturer shall demonstrate, in writing, the Quality Assurance Program in use to certify key components. In-house manufacture of key components is desirable and will be considered in evaluating acceptance.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. National Electrical Code (NEC) current adoption.
   2. City of Phoenix – Amendments to the National Electrical Code.
   3. Standards of National Electrical Manufacturers Association.
   4. Institute of Electrical and Electronic Engineers.
   5. American Gear Manufacturers Association.
   6. National Fire Protection Association 79, Electrical Standard for Industrial Machinery.
   7. UL 508C, UL Standard for Safety Power Conversion Equipment.
   8. ANSI/NETA ATS-2017, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

D. For the equipment specified herein, the manufacturer shall be ISO 9000 or 9001 certified.

E. Unit Responsibility: Assign Unit Responsibility as specified in Section 11 00 00, General Equipment Provisions, to the manufacturer or supplier for the equipment specified in this Section. A Certificate of Unit Responsibility shall be provided.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Refer to and comply with the requirements of Section 01 33 23.10, Shop Drawing Procedures.
   2. CONTRACTOR shall submit an electronic copy per Specification Section 01 33 23.10, Shop Drawing Procedures. Text shall be in electronic ASCII format. Drawings and figures shall be in Version 2012 or newer AutoCAD ".dwg," or pdf ".pdf" format.
   3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (□) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The CONTRACTOR shall furnish equipment and/or services as specified if an exception and/or deviation is rejected. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. The CONTRACTOR shall submit the preventive maintenance information package as part of the shop drawing submittal package to the ENGINEER for review and approval. SHOP DRAWING SUBMITTAL PACKAGE WILL NOT BE APPROVED WITHOUT ACCEPTANCE OF PREVENTIVE MAINTENANCE INFORMATION AS DESCRIBED IN SPECIFICATION SECTION 01 78 23.
   5. Manufacturer's literature, illustrations, specifications and engineering data that indicates performance, dimensions, materials, size and weight.
   6. Floor plans, drawn to scale, including, but not limited to:
      a. Dimensioned layout showing required working clearances and required area above and around the VFD’s.
      b. Relationships between electrical components and adjacent structural and mechanical elements.
      c. Support locations, type of support, and weight on each support.
   7. Schematics, including all interlocks.

8. Wiring diagrams, including all internal and external devices and terminal blocks.
9. Complete list of components and catalogue identification.
10. Complete list of options provided, including catalog number breakdown showing options provided.
11. List of in-house manufactured key components.
12. Quality Assurance Program description.
11. Recommended spare parts list.
12. Test Reports: Electrical Acceptance Testing shall be done in accordance with NETA ATS 2017 Standard.

B. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

C. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules. Include specific instructions on how to upload and download all programming.
6. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
7. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
8. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.
9. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
10. Furnish list of final parameters and function selections programmed into each drive control module.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage that exists to

equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all electrical and electronic equipment, control panels, and like equipment and materials in climate-controlled buildings that have a concrete or wooden floor, a roof, and fully closed walls on all sides. Protect electrical and electronic equipment from contamination by dust, dirt and moisture. Maintain humidity at levels recommended by manufacturer for electric and electronic equipment.

E. Energize space heaters during storage.

1.5 SHOP TESTS

A. Each variable frequency drive (VFD) shall be tested at the manufacturer's facility.

B. In addition to the manufacturer's standard tests, each VFD, including all instruments, controls, solid state components, systems, and internal and external equipment which are a part of the VFDs shall be assembled, tested and thoroughly checked for proper operation of all functions and features. Simulated signals and loads shall be employed that shall simulate actual signals and loads if they are a part of the final installation and are not included in this Section.

C. If the test results indicate that any VFD unit does not conform to specified and/or guaranteed performance, the unit shall be modified and retested at no additional cost to OWNER until full compliance with specified and guaranteed performance can be demonstrated. OWNER and/or ENGINEER shall be permitted to witness the retest.

D. No equipment shall be shipped until the ENGINEER has approved all test reports.

1.6 WARRANTY

A. The variable frequency drive manufacturer shall warranty the units being supplied to the OWNER against defects in workmanship and material for a period of five years under normal use, operation, and service. The warranty shall cover parts and labor and shall be in printed form and apply to all similar units.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install variable frequency drive units, AC PWM inverter type, 460 volts, sine coded with carrier frequency adjustment, 3 phase, 60 hertz input with

output suitable for and coordinated with the driven equipment furnished under the appropriate Sections in Division 11, Equipment.

B. Drives rated larger than 200HP shall be an Active Front End (AFE) AC drive that is designed to comply with IEEE 519-2014 standards for THD and TDD. Compliance to IEEE 519-2014 shall also be required when installed in a system that is already in compliance with the standard. AFE drives shall be of the pulse-width modulated type and shall consist of an active front end with insulated gate bipolar transistors (IGBTs).

C. Incoming power shall be filtered by an integral inductor-capacitor-inductor (LCL) filter. The filter shall filter out the high frequency content of the IGBT front end. The drive shall be able to boost the incoming voltage by 20% and ride through voltage dips of 35%. Power factor shall be adjustable as leading or lagging by up to 20%.

D. The main control board for the IGBT input shall be identical to the main control board for the IGBT output. The drive shall be equipped with an integral input contactor that opens when the drive is not running and closes when a drive run signal is initiated.

E. The VFD inverter output shall be generated by IGBTs which shall be controlled by identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst-case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

F. VFD Motor Control Panels (MCP)
   1. Control Panels shall be furnished in accordance with the requirements as shown on the Drawings and as specified in Division 40, Sections 40 61 96, Computer Control System Process Control Descriptions, 40 70 00, Process Control System Primary Sensors and Field Instruments, 40 06 70, Process Control System Instrument Index, 40 61 93, Process Control System I/O List and 40 67 00, Control Panels. All panel enclosures shall conform to the requirements of specification 26 05 01 – General Provisions.

G. VFD General Features
   The drives shall have the following characteristics:
   1. Output voltage (Maximum): 460 volts.
   2. Frequency stability: ±0.5 percent of nominal (at 25°C ±10°C).
   3. Frequency range: 3 to 67 hertz, selectable by switch to 120 hertz (Except where otherwise indicated).
   4. Volts per hertz ratio (V/HZ) adjustable for 3 to 60 hertz.
   5. Overload capacity shall be one minute at 125 percent of continuous constant torque rated nameplate current. The inverter shall be designed to not be internally shutdown within the 125 percent overload operating range.
   6. Constant torque rated for motor nameplate horsepower without revision of inverter unit manufacturer's nameplate published constant torque rating.
   7. Acceleration/deceleration time shall be adjustable over a range that meets the requirements of the drive equipment.

8. Adjustable overvoltage and under voltage protection with automatic restart.
9. Drive shall meet the requirements of IEEE C62.41.
10. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449.
11. Loss-of-phase, Reverse phase and Short circuit protection.
12. Motor-overtemperature fault.
13. Ethernet Communication: Provide a dual-port Modbus TCP Ethernet module in VFD. Provide any module, interface, configuration, and programming required to communicate to the Modicon M580 PLC via Ethernet. VFD shall be capable of all monitoring and control from the PLC via Ethernet.

H. VFD's shall meet all requirements as outlined in the latest edition of IEEE 519 for total harmonic voltage and current distortion and as indicated in this Section. Individual or simultaneous operation of the VFDs shall not add more than three percent total harmonic voltage distortion while operating. Maximum allowable total harmonic current distortion limits for each VFD shall not exceed five percent as calculated and measured at the point of common coupling. The point of common coupling for all harmonic calculations and field measurements for both voltage and current distortion shall be defined as the nearest upstream MCC or switchboard. A preliminary harmonic analysis must be submitted by the VFD manufacturer with Shop Drawings which includes all voltage and current harmonics up to the 99th harmonic; for this purpose, cable lengths can be estimated on a conservative basis by CONTRACTOR. Compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the defined point of common coupling with and without the VFD's operating.

I. Product and Manufacturer: Pending compliance with the Drawing, Specifications, and dimensions (foot prints and heights), provide one of the following. Please note that custom work may be required to fit the proposed VFDs into the indicated spaces.
1. Square D
2. ABB
3. Eaton

2.2 DETAILS OF CONSTRUCTION

A. All individually mounted VFD's shall be housed in NEMA 1 wall or floor mounted cabinets configured as shown on the Drawings. All other VFD's shall be housed within motor control centers (VFD's in motor control centers shall be built by the same manufacturer as the motor control centers) and configured as shown on the Drawings. VFD cabinets shall be individually fed from circuit breakers located in the motor control centers as shown on the Drawings. Conduit and cable entrances shall be from either top or bottom. VFD's shall be located as shown on the Drawings. **Caution:** Verify space limitations for units with bypass contactors. Verify space around VFD cabinet for airflow requirements per manufacturer’s recommendations. Space shall be verified for future units.

B. The VFD units shall require front access only and shall be suitable for against-the-wall installation. Bypass contactors, where required, shall be integral to VFD enclosure along with the overload relay.

C. All VFD units shall have a padlocking arrangement permitting the disconnect device to be locked in the OFF position.

D. Identify VFD's, components, and control wiring.
   1. Provide laminated plastic nameplates with a white background and black lettering for identification of components.
   2. Cable/Wire Markers:
      a. Provide only heat shrinkage type cable/wire identification, which shall be type-written.
      b. Wire numbers inside VFD panel shall follow Manufacturer's wire numbers as listed in Control Schematics.
      c. Wire number from outside VFD panel shall include the conduit number and be a consecutive number based on the number of wires in a conduit, starting with number 1; example C18J – 1, whereas C18J is the conduit number and 1 is the first wire. If ten wires are in a conduit, the numbering would be C18J-1 through C18J-10. No two wires are to have the same number.
      d. Product and Manufacturer: Provide the following: W.H. Brady Company. (Part # PSPT-187 for a single conductor) or equal.

E. Provide control devices and indicating lamps in accordance with Section 40 67 00, Control Panels.

F. The VFD enclosure and its components shall not intrude into the cable tray and cable tray construction. Custom work on the VFD enclosure (and its components) may be necessary to accommodate this requirement.

G. The VFD enclosure and its components shall not exceed the width allotted as indicated in the Floor Plan Drawings. Custom work on the VFD enclosure (and its components) may be necessary to accommodate this requirement.

2.3 OPERATIONAL DESCRIPTION

A. Operational sequences shall be as shown on the Drawings and described in the applicable Sections of Division 11, 26 and 40 of these Specifications.

2.4 OPTIONAL VFD COMPONENTS (REQUIRED)

A. Provide a dual port Modbus TCP/IP Ethernet Module.
B. Provide front panel Ethernet Port for laptop access.
C. Provide damper control circuit with end-of-travel feedback capability.
D. Motor Preheat Function: Perheats motor when idle to prevent moisture accumulation in the motor.
E. Elapsed-time meter.
F. Kilowatt meter.
G. Kilowatt-hour meter.

2.5 MANUFACTURER

A. The VFD's listed in this Division and in other Divisions shall be the product of one manufacturer. The VFD assembler shall be the manufacturer of the power inverter.

2.6 TRANSIENT CONDITIONS

A. The drives shall be capable of accepting a supply variation of 460 volts plus five percent or minus ten percent at 60 hertz plus or minus two hertz as a standard design feature.

B. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations. The maximum total harmonic distortion (THD and TDD) allowed at the points of analysis shall include harmonics from the existing equipment as well as the harmonics from equipment provided under this section.

C. The drives shall be of the diode bridge rectifier front-end type to minimize electrical noise generation and to operate at not less then 95 percent power factor over the full operating range.

D. For sustained or momentary power outages, the drives shall have a safe shutdown design with automatic ramp-up return to normal operation upon restoration of power.

E. For momentary voltage dips, which shut down the drive, means shall be provided for automatic ramp-up return to full, controlled operation upon restoration of full line voltage.

2.7 ENVIRONMENT

A. The drive shall be capable of operating under any combination of the following conditions without mechanical or electrical damage:
   1. Ambient temperature: 0 to 50°C.
   2. Relative humidity: 0 to 95 percent non-condensing.
   3. Vibration: 0 to 0.5G.

2.8 CONTROL REQUIREMENTS

A. Current limit circuitry shall automatically phase back voltage and frequency to decrease current to 125 percent of the drive rated capacity.

B. The drive and inverter shall be UL listed and labeled by a nationally recognized testing laboratory.

C. The variable speed drive system shall include a diode bridge converter, filter network and a transistorized inverter section. Base driver signals used to control firing of the power transistors shall be designed with optically coupled isolators.

D. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls with password protection with at least three levels of access: View only; view and operate; and view, operate, and service.

2.9 PROTECTIVE AND OPERATIONAL CHARACTERISTICS

A. The drives shall have the following protective and operational characteristics in addition to those previously described:
   1. Adjustable current limit.
   2. Overcurrent trip (125 percent).
   3. Short circuit trip (hall-effect current transformer).
   4. DC bus overvoltage trip.
   5. DC bus fuses.
   6. Line undervoltage trip (-30 percent) with automatic restart on voltage recovery.
   7. Momentary power failure trip (greater than ten milliseconds) with automatic restart.
   8. Line input 3-pole circuit breaker with current limiting fuses interlocked with the unit door. Circuit breaker shall be padlock able in the "OPEN" position.
   9. Output signal of 4 to 20 mADC proportional to speed.
   10. Process follower to accept 4 to 20 mADC signal input.
   11. By-pass contactor with overload relay with external or programmable reset where required by the Drawings. Contactors shall be NEMA Type S rated. Half sizes and IEC rated contactors shall not be acceptable. NEMA dual rated contactors shall not be acceptable.
   12. LED display of the following:
      a. Overcurrent trip at 125 percent.
      b. Internal component short circuit.
      c. Output short circuit.
      d. Overload (when soft stall not selected).
      e. Overvoltage on DC bus.
      f. Overvoltage on input.
      g. Undervoltage.
      h. Overheat.
      i. Ground Fault.
      j. Initial parameter mismatch.
      k. Frequency meter
      l. Run / Stop Indication
   13. The VFD shall provide electronic motor overload protection qualified per UL 508C.
   14. An internal microprocessor shall monitor the load on the drive and in the event of an overload it shall, based on the microprocessor's calculation of

the true inverse time overload characteristic, either trip out or phase back the voltage and speed as selected by an internal jumper.

15. Acceleration time: 1 to 20 seconds adjustable.
16. Dynamic braking: 12 percent standard.
17. Ramp to stop: 1 to 20 seconds adjustable.
18. Speed control integral to the programmable control module.
19. Local/Remote operation solid-state selector switch to be integral to the programmable control module. Provide a dry contact output from the programmable control module to indicate position of the Local/Remote switch.
20. Isolated contacts for remote indication of "RUNNING", “Computer Mode Selection”, VFD Fault and all other alarm conditions , as required by the Drawings.
21. Normal/bypass selector switch (for units with by-pass contactors) if feature is not available from the programmable control module.
22. Fault reset button on door if fault reset feature is not available from the programmable control module.
23. Input line reactor (inductor), three percent for 6-pulse VFDs (not required for active front end).
24. Coordinated short-circuit rating designed to UL 508C or UL 61800-5-1 and NEMA ICS 7.1 short-circuit rating: 100kAIC minimum.
25. All additional devices as shown on the Drawings and specified herein.

B. The drive units shall be able to withstand phase-to-phase and phase-to-ground shorts without damage to the drive unit.

C. The drive shall include the solid-state features described above on plug-in circuit boards with microprocessor and on-board diagnostic circuitry with LED readouts as listed above.

D. The drive shall have integral transformers to supply all required control voltages including space heaters, where required. The control transformer and entire drive unit shall be de-energized when the line disconnect switch or circuit breaker is opened.

E. Fault trip conditions, except short time or momentary line voltage loss or line voltage momentary dip, shall lock out the control. Resetting of control after fault trip shall be manual by a door-mounted pushbutton.

F. Auto restart shall be a standard feature of the drive as follows:
   1. Auto restart shall be enabled or disabled by programming or jumper selection.
   2. On auto restart selection, the microprocessor shall determine, in the event of a fault, if a restart should be attempted. A restart shall be attempted under the following conditions:
      a. Undervoltage (UP): Every time as soon as voltage returns to a safe level. Fault relay shall not be activated.
      b. Input Overvoltage (OPS): Every time as soon as voltage returns to a safe level. Fault relay shall be activated for the duration of the high voltage condition.

c. Overcurrent (OC): Five attempts in 30 seconds. After the fifth OC, the drive shall trip out and latch the fault relay.

G. A restart shall not be attempted for any other type of fault and the drive shall trip out immediately, activate the fault relay, and make the information available on the programmable control module display until the drive is manually reset.

H. An undervoltage condition of less than 30 ms duration shall not affect drive operation. If main power falls below 85 percent of rated voltage for longer than 30 ms while control power is retained, the drive shall forcibly decelerate the load in an attempt to force a higher bus voltage through regeneration to allow the drive to "ride through" the undervoltage condition for up to 70 additional milliseconds for a total "ride through" of up to 100 ms for very high inertia loads. The manufacturer shall provide an option that allows control power to be maintained for 100 ms in the event of a power failure. If the drive drops out, it shall automatically restart upon restoration of full rated voltage, as previously described.

2.10 FACTORY TESTS

A. The testing procedure shall be the manufacturer's standard procedure to assure maintenance free service. The OWNER shall be given 14 days notice prior to start of factory testing so that the OWNER, at his option, may witness the testing.
1. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The VFD shall trip electronically without device failure.
2. After all tests have been performed; each VFD shall undergo an 8-hour burn-in test. The VFD's shall be burned in at 100 percent inductive or motor load for 8 hours without an unscheduled shutdown.
3. ~~After the burn-in cycle is complete,~~ each VFD shall be put through a 30-minute cycling motor load test before inspection and shipping.
4. Certification that all of the testing above has been performed shall be provided by the VFD manufacturer, upon request.

B. All equipment, devices, instrumentation, and personnel required to perform the tests shall be supplied by the manufacturer. Upon satisfactory completion of the test, the manufacturer shall submit two certified copies of the test report to the ENGINEER. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

2.11 PAINTING

A. Units shall receive manufacturer's standard finish paint system prior to shipment.

B. Machined, polished, and non-ferrous surfaces shall be coated with corrosion prevention compound.

C. Painting shall conform to the requirements of Section 26 05 01, General Equipment Provisions, and Section 09 90 00, Painting and Coating.

D. All internally electronic components, devices terminations and other items shall be coated with an epoxy based conformal coating system.

PART 3 - EXECUTION

3.1 START-UP AND TEST

A. Make all adjustments required to place system in proper operating condition.

B. A manufacturer's representative shall check and approve the installation before operation. He shall test operate the system in the presence of the ENGINEER and verify that the units conform to requirements. He shall revisit the jobsite as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. Electrical Acceptance Testing shall be done in accordance with the latest NETA ATS Standard.

3.2 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of three (3) visits, minimum sixteen (16) hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the variable frequency drives conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR’S bid price.

+ + END OF SECTION + +

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SECTION 43 25 00

SOLIDS HANDLING WET WELL PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install vertical submersible well pumps complete and operational with motors, control equipment, and accessories as shown on the Drawings and as specified. Anchor bolts are included in this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. All equipment provided under this Section shall be obtained from a single supplier or manufacturer who, with CONTRACTOR, shall assume full responsibility for the completeness of the system. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.

C. Unit Responsibility: Assign Unit Responsibility as specified in Section 11 00 00, General Equipment Provisions, to the manufacturer or supplier for the equipment specified in this Section. A Certificate of Unit Responsibility shall be provided.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Standards of the Hydraulic Institute.
   2. National Electrical Code (NEC) current adoption.
   3. City of Phoenix – Amendments to the National Electrical Code.
   4. Standards of National Electrical Manufacturers Association.
   5. Institute of Electrical and Electronic Engineers.
   6. American National Standards Institute.
   7. Standards of American Water Works Association.

E. Shop Tests:
   1. Each pump casing shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.
   2. Running Test: Each pump assembly shall be operated from zero to maximum capacity as shown on the approved pump curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, current and NPSH. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate. Curves shall be corrected for column and

discharge head losses, shaft friction loss and operating speed to show the anticipated field performance of the complete pump assembly.

3. Each test shall be witnessed by a Registered Professional Engineer who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. Tests shall be conducted in conformance with the Standards of the Hydraulics Institute.
4. Pumps shall not be shipped until the ENGINEER has approved the test reports.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, paint certification, specifications and engineering data including: dimensions, materials, size, weight, performance data and pump curves showing overall pump efficiencies, required net positive suction head, flow rate, head, brake horsepower, motor horsepower, speed and shut-off head. Supply data on pump head losses, to include entrance, column, pump and valves losses.
   2. Provide: Fabrication, assembly, installation and wiring diagrams.
   3. Certified pump tests.
   4. Motor test results and data.
   5. List of all deviations from Contract Documents.
   6. Control panels shall be furnished in accordance with the requirements as shown on the Drawings and as specified in Division 40, Sections 40 61 96, 40 70 00, 40 06 70, 40 61 93 and 40 67 00.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Pumps shall be self-cleaning, non-clogging (pump shall be able to pass solids with minimum sphere size of 3-inch), submersible sewage pump, suitable for pumping raw wastewater. The pumps, with appurtenances and cable, shall be designed for continuous operation under submergence, without leakage, in water to a depth of five (5) feet.

B. The pump(s) shall be automatically and firmly connected to the discharge connection guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with 50 feet of lifting chain or stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight. Power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment loops or tails to connection to the underside of the access frame.

C. The characteristic curve of the pump shall rise from minimum head condition to shutoff without dips. The complete pumping unit consisting of the pump and respective motor shall be suitable in all respects for continuous, stable performance when operating at any point on the characteristic curve without cavitation or runout and in accordance with the vibration criteria specified herein.

D. Each complete pumping unit, including the motor, shall be capable of safely operating at up to 125 percent of full load speed in reverse rotation without sustaining damage.

E. Pumps shall be specially designed, constructed, and installed for the service specified and shall comply with the design conditions as specified herein.

Design Conditions	**Pump No. 1 through Pump No. 6**
Location:	Wet Well
Use:	Raw Wastewater
Number Required:	6
*Design Flow: gpm	2,940
*Design TDH: ft.	234
Min. Bowl Efficiency at Design: %	58%
Motor Type	NEMA Premium efficiency, induction motor, operated by a Variable Frequency Drive (VFD). Nameplate must include “Inverter Duty”.
Motor: hp	470 hp
Max. Operating Speed: rpm	1,200 rpm
Discharge Size: in.	14-inch
**Available NPSH:	28 ft (Min) and 33 ft (Max)
NPSHR at Design:	19 ft
NPSHA:	20 ft (Min) and 33 ft (Max)
Run Out Condition:	Flow: 9,000 GPM TDH: 150 feet Minimum Overall Efficiency: 70%
Secondary Design Condition:	Flow: 6,000 GPM TDH: 194 feet Minimum Overall Efficiency: 78%
Max Shutoff Head: ft.	300
Approx. Static Liquid Elev. in Well: ft	Can vary from 5 ft to 11 ft
Elev. of Pump: ft	See Drawings.
Pump Discharge Center-line Elev.: ft	See Drawings.
Liquid Pumped:	Raw Wastewater
Drive Type:	Variable Speed Drive
Motor: Volts/Phase/Hertz	480V, 60 Hz, 3 Phase
Enclosure:	Pumps including power cable shall be provided in Explosion Proof in accordance with Class 1 Division 1 Group C and D. Motors shall be (Explosion proof), FM Approved for Hazardous locations, Class 1 Division 1 & 2 Group C and D. The motor shall have Class H insulation.

* Does not include entrance, pump, column, and discharge head losses.

** Required NPSH shall be for size impeller being furnished. If impeller is trimmed, curve for that impeller shall be submitted.

*** Flow at the 2nd design point TDH shall be within ten percent of the value specified.

2.2 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:

1. Pump volute shall be single-piece grey cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.
2. Pump and motor shaft shall be a solid continuous shaft. The pump shaft is

an extension of the motor shaft. Pieced shafts or the use of couplings shall not be acceptable. The pump shaft shall be of AISI 431 stainless steel and shall be completely isolated from the pumped liquid.

3. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. The Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. For special applications, other seal face materials shall be available. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.

   The following seal types shall not be considered acceptable or equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to affect sealing shall be used.

   Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate continuously while non-submerged without damage while pumping under load. Seal lubricant shall be non-hazardous.

4. The impeller shall be of Hard-Iron® (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim

screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

5. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard-Iron ® (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.
6. Anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations. The anchor bolts shall be Type 316 stainless steel.
7. Stainless steel manufacturer's nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.
8. Each pump/motor unit shall be equipped with an integral, closed-loop motor cooling system. The motor cooling jacket shall encircle the stator housing and shall be of Type 304 stainless steel. The closed-loop motor cooling system shall provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air in dry-pit installation mode. A high efficiency impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the system. The cooling liquid shall pass about the stator housing in the closed loop system between the motor housing and close-fitting guide sleeve in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C) in accordance with NEMA standards. Operational restrictions that limit the ambient or pumped liquid temperatures at levels less than 40°C are not acceptable.

B. Motors

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the current-UV-dip impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum.
2. The pump shall be furnished and installed with standard Flygt MAS801 sensors including PT-100 (lower bearing), PT-100 (upper/support bearing), PT-100 (one stator winding), FLS in the junction box, FLS in the Stator Housing, Current Transformer (single phase), Vibration (x, y and Z-axis - three (3) plane), PEM -

pump module internal that all above sensors wire in for a 2-wire communication output to the MAS801. Furnish the MAS801 system as shown in the electrical and instrumentation DRAWINGS. The project System Integrator, as specified in section 40 67 00, shall install the furnished Flygt MAS801 systems into the PCP and make it fully functional as required by contract documents. The motor and the pump shall be produced by the same manufacturer.

3. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
4. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.
5. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-ou
6. The pump shaft shall rotate on at least three grease-lubricated bearings. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.
7. The minimum L10 bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.
8. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.
9. The upper support bearing, provided for radial forces, shall be a single roller bearing and shall have an insulated outer ring to provide protection against potential bearing damage from electrically induced currents that can be created especially when the motor is used with a VFD. The outer ring shall have a plasma-spray technique or oxide-ceramic coating that provides an insulating barrier between the bearing face and the bearing housing of the pump.
10. Motors shall conform to the requirements of Section 43 28 13, Electric Motors Larger than 250 Horsepower.
11. Cable entry shall be isolated with an internal terminal board.
12. Motor shall be non-overloading for the entire pump operating curve.
13. Pump motor cable shall be designed for submersible duty and shall be indicated by code or legend permanently applied to cable. Cable and sizing shall conform to National Electric Code for pump motors and shall be supplied in sufficient length to extend continuously, without splices, from the motor to the pump splice box. The power cable entry assembly shall be stainless steel and shall be provided with a strain relief element to inhibit leakage in the event the cable is pulled. Motor power cords shall meet the requirements of the Mine Safety and Health Administration for trailing cables.
14. Motor thrust bearings shall be designed for continuous thrust loads under all conditions of pump operation from zero head to shut-off.

C. Submersible Cable:

1. Pump cable must sized for not more than 0.5% voltage drop. Cable length as needed, including cable management, for routing to local terminal panel. Cable must be listed / constructed for operation on a VFD.
2. Conductor Size: Size to limit voltage drop to six percent at the motor.
3. Cable Clamps:
   a. Large Pumps: Clamps used to secure the cable to the discharge column shall be stainless steel with rubber cable protectors. Place clamps at least every 20 feet, minimum.
   b. Small Pumps: Clamps used to secure the cable to the discharge column shall be electrical wire tie wraps or 20 mil electrical pipe wrap.
4. Cable Length: Provide as required to connect to pump control panel.
5. Cable Shield: Cable shield at pump bowls shall be of 300 series stainless steel.
6. Pump motor cable shall be designed for submersible duty and shall be indicated by code or legend permanently applied to cable.

D. Deep Lifting System:
   1. The pump supplier shall provide a single pump installation and retrieval system designed to operate with the pump units supplied. The pump supplier shall have complete responsibility for the function of the pump retrieval system and shall provide a warranty for the system.
   2. The deep lift system shall be fabricated from ASTM-A36 steel and shall have be rated for no less than 3 times the largest pump and motor's weight capacity.
   3. The lifting mechanism shall be coated with a minimum two part, epoxy paint system.
   4. The deep lift system shall provide a method to facilitate the installation and retrieval of the submersible pumps from the wet well regardless of station depth. There shall be no need for station personnel to enter the wet well in order to install or retrieve pump units.
   5. The deep lift pump lifting device shall utilize the hoist system designed for the pump station. No accessory lifting chain or cable shall be required. The unit shall have an integral set of guide rollers to facilitate vertical linear movement in the wet well along the pump guide bars. Upon meeting the pump lifting bail, the device shall automatically and securely engage the lifting bail. There shall be no possibility of release of the pump unit from the lifting device once engaged to the bail. After the pump unit is placed upon the service floor, a manual release of the lifting pin shall be required to disengage the lifting device. The device shall not utilize any springs to engage or disengage the pump lifting bail.
   6. When installing a pump unit, once the lifting pin is seated against the invert of the lifting bail, a counter weight shall be affixed to the lifting pin so as to facilitate its automatic release when the pump unit has properly seated upon the discharge connection within the station wet well. Visual identification shall be provided to determine whether the device is engaged in the lifting bail with red and green reflectors and can be observed from above at grade level.

E. Product and Manufacturer: Provide one of the following:
   1. Flygt N- Technology, Model NP3312, Wastewater Pumps or Approved Equal.

2.3 SURFACE PREPARATION AND PAINTING

A. All surfaces shall be cleaned with grease emulsifying agents and then rinsed. Parts shall be blasted to remove surface contaminants, rust, foreign particles shall be removed thoroughly. Pumps, motors, drives, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09 90 00, Painting and Coating. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09 90 00, Painting and Coating.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop coating system conform to the requirements of Section 09 90 00, Painting and Coating.

2.4 CONTROLS

A. Provide pump controls as shown on the Drawings and specified in Division 40, Sections 40 61 96, 40 70 00, 40 06 70, 40 68 70, and 40 67 00.

B. Pumps shall be furnished with the following controls:
   1. Refer to Section 40 61 96 – Process Control Descriptions.

PART 3 -EXECUTION

3.1 INSPECTION

A. Inspect all equipment immediately upon delivery to site. If damaged, notify ENGINEER and manufacturer immediately.

B. Do not install damaged equipment until repairs are made in accordance with manufacturer's written instructions and approved by the ENGINEER. Only minor repair work shall be permitted in the field. All other damaged items shall be sent to factory for repair or replacement.

3.2 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's instructions and recommendations and the approved Shop Drawings. The installation shall be certified on Form 01620-A specified in Section 01 33 10, Reference Forms.

B. A check valve and shut-off valve in discharge piping are required for each pump as shown on the Drawings.

C. Support piping independent of pump.

3.3 START-UP AND TEST

A. Make adjustments required to place system in proper operating condition. Field test and calibrate the equipment to assure that the system operates in accordance with these Specifications and to the satisfaction of the ENGINEER.
B. During the field acceptance tests, observations shall be made of head, capacity, and motor input. All defects or defective equipment revealed by or noted during the tests shall be corrected or replaced promptly at the expense of the CONTRACTOR and, if the Owner deems it necessary, the tests shall be repeated until results acceptable to the Owner are obtained. The CONTRACTOR shall furnish all labor, piping, equipment, and materials necessary for conducting the tests.
C. The field acceptance tests shall include measuring or determining the following items:
    1. Power input.
    2. Flow rate
    3. Minimum VFD speed setting.
    4. Static head on the pump.
    5. Total head on the pump.
    6. Correct pump rotation.
    7. Proper seating of the pump to the discharge connection.
D. On those pumps or sets of pumps that have a flowmeter in the discharge line, the flowmeter may be used to determine the pump flow rate once its accuracy has been verified in the field.
E. The pump manufacturer's representative shall conduct field vibration testing per HI Standard 11.6.9 and submit results for review. CONTRACTOR shall install temporary instrumentation required for the testing procedure per the guidelines of HI. Each pumping unit shall be tested to ensure vibration limits are not exceeded.
F. In the event the CONTRACTOR is unable to demonstrate to the satisfaction of the Owner that the units will satisfactorily perform the service required and that they will operate free from vibration and overheating, the pumping units may be rejected. The CONTRACTOR shall then remove and replace the equipment at his own expense.
G. All defects and defective equipment shall be corrected promptly or replaced at the expense of the CONTRACTOR.
H. All final adjustments necessary to place the equipment in satisfactory working order shall be made at the time of the above tests. After completion of installation, the system shall be completely tested to ensure compliance with the operating requirements as specified, indicated on the Drawings and in accordance with Section 01 75 16, Equipment and System Startup and Performance Testing.
I. CONTRACTOR shall discharge the water for pump tests to adjacent sewer. Costs of retesting shall be at no additional cost to owner.

3.4 MANUFACTURER'S SERVICES

A. A factory-trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, minimum 8 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01 79 00,

Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the pumps conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S lump sum bid price.

+ + END OF SECTION + +

SECTION 43 28 11

ELECTRIC MOTORS 250 HORSEPOWER OR LESS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes alternating current induction motors, 250 horsepower or less, to be provided with the driven equipment. Unless specified otherwise, electric motors shall be provided by the manufacturer of the driven equipment under an assumption of unit responsibility. This Section refers to motors by enclosure type as defined in NEMA MG 1, except as noted.

B. Horsepower Rating:
   1. Motor horsepower ratings noted in individual equipment Specifications are estimates only and it is the responsibility of CONTRACTOR to furnish motors, electric circuits, and other equipment of ample horsepower capacity to operate the equipment furnished without exceeding the manufacturer's nameplate full-load current at rated manufacturer's nameplate voltage. Full-load current information shall be furnished with the individual submittals

1.2 QUALITY ASSURANCE

A. General: Motors shall be built in accordance with UL 1004, NEMA Standard MG 1, and to the requirements specified.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail
   1. AFBMA 9: Load Rating and Fatigue Life for Ball Bearings.
   2. AFBMA 11: Load Ratings and Fatigue Life for Roller Bearings.
   3. IEEE 112: Standard Test Procedures for Polyphase Induction Motors and Generators.
   4. IEEE 841, Standard for Petroleum and Chemical Industry - Totally Enclosed Fan Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP.
   5. NEMA ICS 2: Industrial Control Devices, Controllers and Assemblies.
   6. NEMA ICS 6: Enclosures for Industrial Controls and Systems.
   7. NEMA 250, Enclosures for Electrical Equipment (1000 volts maximum).
   8. NEMA MG 1: Motors and Generators.
   9. NEMA MG1-31: Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose

Motors Used with Adjustable-Voltage or Adjustable- Frequency Controls or Both.

10. UL 1004: Electric Motors.

C. Factory Tests: The manufacturer's factory motor Prototype Tests per IEEE Standard 112 Appendix-A on motors through 250 horsepower shall be submitted as Product Data for the motor, and actual factory tests for motors are not required:
   1. Winding resistance in ohms and converted to 25 degree C.
   2. Resistive Unbalance and Quarter Voltage Impedance, as applicable.
   3. Locked-Rotor current (Single phase).
   4. High Potential.
   5. No-Load Excitation (volts, amperes, RPM).
   6. Bearing vibration check.
   7. Efficiency, Power Factor, Current at 115%, 100%, 75%, 50%, and no load.

D. Warranty:
   1. Motors ½ horsepower and greater shall be warranted against defects in materials and workmanship for a period of 5 years under the specified uses and with normal operation and service. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor during the first 60 months of operation.

E. Unit Responsibility: Assign Unit Responsibility as specified in Section 11 00 00, General Equipment Provisions, to the manufacturer or supplier for the equipment specified in this Section. A Certificate of Unit Responsibility shall be provided.

1.3 SUBMITTALS

A. Submittals shall include the following:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole.
   2. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
   3. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.
   4. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification

requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

5. Manufacture completed IEEE Standard 841 Date Sheet for AC Squirrel Cage Induction Motors with required factory data of motors supplied.
6. Speed-Torque curve per 1.2 C Factory Tests.
7. Factory Test Data: Including Guaranteed Minimum Efficiency for 115% load, 100% load, 75% load, 50% load, and no load.
8. Guaranteed vibration level when measured per MG 1, Figure 7-6:
   a. Displacement: 0.0025 inch peak-to-peak
   b. Velocity: 0.10 inches per second peak
   c. Acceleration: 1g (gravity) peak.
9. Motor heating curve for motors per 1.2 C Factory Tests.
10. Motor outline, dimensions, and weight.
11. Manufacturer's descriptive information relative to motor features.
12. Response curve where a winding over-temperature device is required.
13. For all inverter duty motors: Manufacturer's certification that the motor is compatible with the adjustable frequency drive to be used.
14. Disassembly and repair documentation.

1.4 POWER SUPPLY VARIATIONS

A. Motors shall operate successfully under running conditions at rated load with +/- 10-percent of rated voltage with rated frequency or +/- 5-percent of rated frequency with rated voltage.

1.5 AMBIENT CONDITIONS

A. Unless specified otherwise, motors shall be suitable for continuous operation at an elevation of approximately 1,000 feet above mean sea level. Motors to be installed outdoors, exposed to the weather, shall be suitable for continuous operation in a 50° C ambient temperature; motors to be installed indoors shall be suitable for continuous operation in 50° C ambient temperature, unless otherwise noted.

1.6 NEMA WINDING TEMPERATURES

A. NEMA MG 1 Table 12-7 motors insulation system maximum winding temperatures in degrees-Centigrade (C), with the degrees-Fahrenheit (F) insulation system class specified herein.
   1. Forty degree-C ambient (104 degree-F) is the basis for temperature rise.
   2. For 50 degree C ambient (122F) and above, refer to the driven equipment specifications for additional requirements.

Insulation System Class	Degrees C / F	Temperature Rise by Resistance
A	140 / 284	NA
B	165 / 329	B-rise: 40 + 80 = 120 Degrees C / 248 F

F	190 / 374	F-rise: 40 + 105 = 145 Degrees C / 293 F
H	215 / 419	H-rise: 40 + 125 = 165 Degrees C / 329 F

1.7 NEMA MOTOR TEMPERATURE PROTECTION TYPES

A. The NEMA design shall limit the temperatures of the windings without using a thermal device:
   1. Type-1: Winding Running and Locked Rotor Over-temperature Protection.
   2. Type-2: Winding Running Over-temperature Protection.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S NAMEPLATES

A. Factory installed manufacturer's nameplates shall be stainless steel with embossed or pre-printed lettering and fastened to the motor frame with Type 316 stainless steel pins. Manufacturer's nameplates shall have stamped on them the motor manufacturer's name, design voltage; number of hertz and phase; horsepower rating; amperage and temperature rise at rated load, full load speed, NEMA code letter, service factor, minimum guaranteed efficiency, model number, AFBMA bearing number, serial number and maintenance manual number in accordance with NEMA MGI-10.40.1.

B. A separate factory installed manufacturer's nameplate shall provide lubrication instructions and a separate manufacturer's nameplate connection diagram for dual voltage motors.

C. Additionally, factory to provide the following information on manufacturer's nameplates or additional manufacturer's nameplates for:
   1. Motors 1/2 horsepower and larger: Indicate the ABMA L-10 rated life for the motor bearings.
   2. Motors 2 to 50 horsepower: Indicate the NEMA nominal efficiency.
   3. Motors 50 horsepower and larger: Indicate NEMA guaranteed minimum efficiency.
   4. Explosion-Proof motors: Indicate UL frame temperature limit code.
   5. Space heater information.
   6. NEMA MG 1 Over Temperature Protection Type Number.

2.2 CONSTRUCTION

A. Unless specified otherwise, all motors provided under this Section shall have the following features of construction and operation:
   1. Motor voltage, speed and enclosures are specified in the detailed equipment Specifications. Motors furnished with equipment shall comply with this Section.

2. All motors shall be of the motor manufacturer's premium energy-efficient design, different from manufacturer's standard product through the use of premium materials, design and improved manufacturing process, that reduces motor losses approximately 40 percent from standard efficient designs.
3. Motor efficiency shall be determined in accordance with NEMA Standard MG1-12.54.1 and guaranteed minimum full load efficiency labeled on manufacturer's motor nameplate in accordance with NEMA Standard MG1-12.54.2 or MG1-10.40.1 below.
4. Minimum efficiencies shall not be less than those listed in Paragraph 2.4.E., below.
5. All motors shall successfully operate under power supply variations in accordance with NEMA MG1-14.30.
6. All motors shall be NEMA Design B with torque and starting currents in accordance with NEMA MG1-12.35 and 12.37, except in special applications requiring higher starting torques where NEMA Design C is permitted.
7. All motors shall have a 1.15 service factor. Polyphase integral horsepower motors shall be sized so that, under maximum load conditions imposed by the driven equipment, for the conditions specified, the manufacturer's motor nameplate rated horsepower and Class B temperature rise will not be exceeded. Motors with a service factor of 1.15 shall be selected for operation within their full load rating without applying the service factor.
8. Each motor shall be of the speed and horsepower specified or required to properly operate the driven equipment, torque characteristics as required by the drive load and suitable for direct coupling or V-belt drive, as shown on the Drawings and specified herein. Motors shall be designed for full voltage starting, unless otherwise specified.
9. Frames shall be of corrosion-resistant cast iron with integrally cast feet or bases. End bells, conduit box and cover and bases shall be cast iron, with precision machined bearing fits, ASTM Type A-48, Class 25 or better. UL approved automatic stainless steel breather drains shall be provided in the lowest part of front and back brackets to allow drainage of condensation on TEFC.
10. Each stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.
11. Insulation materials shall be non-hygroscopic and meet or exceed Class H definition, utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests. Motor temperature rating shall not exceed Class B temperature limits as measured by resistance method when the motor is operated at full load at 1.0 service factor continuously in a maximum ambient temperature of 50° C. Windings shall be copper.
12. Rotor cages for motors 50 HP or less shall be die cast aluminum or fabricated copper. Shafts shall be made from carbon steel. Rotor cages for motors larger than 50 HP shall be copper only.
13. Rotors on frames 213T and above shall be keyed shrunk or welded to shaft and rotating assembly dynamically balanced to NEMA limits in accordance with MG1-12.06. Balance weights, if required, shall be

secured to the rotor resistance ring or fan blades by rivets. Machine screws and nuts are prohibited. The entire rotating assembly between bearing inner caps shall be coated with a corrosion-resistant epoxy.

14. Bearings shall be ball, open, single row, deep groove, Conrad type, and shall have a Class 3 internal fit conforming to AFBMA Std. 20. For belted duty applications, drive end bearing may be cylindrical roller type. Bearings shall be selected to provide L-10 rating life of 100,000 hours minimum. Calculations shall be based on external loads using NEMA applications limits in accordance with MG1-14.41 and typical sheave weights and internal loads defined by the manufacturer, including magnetic pull and rotating assembly weight.
15. Bearing temperature rise at rated load shall not exceed 60° C. Temperature rise shall be measured by RTD or thermocouple at bearing outer race. Bearing AFBMA identification number shall be stamped on manufacturer's motor nameplate.
16. Motor lubrication system shall consist of a sealed bearing or a grease inlet on motor bracket with capped grease fitting on inlet, grease relief plug 180 degrees from inlet, grease reservoir in bracket and grease reservoir in cast inner cap. Motor shall be greased by manufacturer with a premium moisture resistant polyuria thickened grease containing rust inhibitors and suitable for operation over temperatures from -25° C to 120° C.
17. All bolt and cap screws shall be of high strength, SAE Grade 5 zinc-plated and chromatic steel. Screwdriver slot fasteners are unacceptable.
18. All motor parts including frame, brackets, fan cover and terminal box shall receive a minimum of two coats of high grade USDA accepted epoxy paint. Motor assembly shall successfully withstand salt spray tests for corrosion in accordance with ASTM B-117 for 96 hours.
19. All motors shall be painted the same color as the driven equipment.
20. Two-speed motors shall be two-winding motors. Two-speed, one-winding consequential-pole motors that require special motor starters are prohibited.

2.3 MOTORS LESS THAN 1/2 HORSEPOWER

A. General:
   1. Unless otherwise specified, motors less than 1/2 horsepower shall be squirrel cage, single phase, capacitor start, induction run type. Construction features listed in Paragraph 2.2, above, shall be as normally supplied by the equipment manufacturer. Single phase motors shall have Class B insulation, minimum. Small fan motors may be split-phase or shaded pole type. Windings shall be copper.

B. Rating:
   1. Unless otherwise specified, motors shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1, Paragraph 10.35. Dual voltage (115/230) rated motors are acceptable if all leads are brought out to the conduit box. Motors shall be non-overloading at all points of the equipment operation.

C. Enclosures:
   1. Unless otherwise specified, motors shall have totally enclosed fan cooled or totally enclosed non-ventilated enclosures.

2.4 MOTORS 1/2 HORSEPOWER THROUGH 250 HORSEPOWER

A. General:
   1. Unless otherwise specified, motors 1/2 horsepower through 250 horsepower shall be three phase, squirrel cage, full voltage start induction type. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment's starting torque requirements.

B. Rating:
   1. Unless otherwise specified, motors shall be rated for operation at 460 volts, 3 phase, 60 Hz, and shall be continuous time rated in accordance with NEMA Standard MG 1, Paragraph 10.35.
   2. Motors for variable frequency systems shall not be required to deliver more than 80 percent of the motor's service factor rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

C. Enclosure and Insulation:
   1. General: Motors shall be classified as Type 1 (Process) and Type 2 (Explosion proof). Enclosures and insulation systems shall be as specified in the following paragraphs. Temperature rise for all motor types shall not exceed that permitted by Note II, Paragraph 12.42, NEMA MG 1. The insulation shall be non-hygroscopic.
      a. Type 1 Motors (Process): Type 1 motors shall be premium energy efficient motors, totally enclosed, fan cooled. All motors shall have Class H insulation with Class B temperature rise. Motors shall conform to IEEE 841. All internal surfaces shall be coated with an epoxy paint. Motors shall be rated for corrosive atmosphere duty.
      b. Type 2 Motors (Explosion proof): Not Used.

D. Motors for Variable Frequency Drives:
   1. Motors intended for use with variable frequency drives shall be compatible with the characteristics of the intended variable frequency inverters. Motors shall be Type 1 or Type 2 as specified in the detailed Specification. Insulation for all motors operating with variable frequency drives shall be Class H with Class B temperature rise. Variable frequency drive motors shall be premium energy-efficient motors. Motors shall be capable of withstanding a pulse voltage of at least 1750 volts with a rate of rise up to 750V/micro second. The motors shall be certified by the manufacturer as suitable for inverter duty.
   2. All motors connected to variable frequency drives shall be equiped with shaft grounding rings. Shaft grounding devices must be factory installed

or installed by a reputable motor shop with the expertise in the proper installation of the devices. If the shaft grounding devices are not factory installed, a third party shall be engaged to test the installation to ensure no damaging shaft currents are present.

E. Minimum Manufacturer's Nameplate Efficiency: Motor minimum manufacturer's nameplate efficiency, determined in accordance with IEEE 112B testing procedures, when operating on a sinusoidal power source shall conform to the following:

HORSEPOWER RANGE	SPEED, RPM		
	1200	1800	3600
1-2	82.5	84.5	82.5
3-5	89.5	88.5	86.5
7-25	90.2	90.2	89.5
30-60	92.4	92.4	89.8
75-250	94.1	93.7	91.7

F. Vertical Motors:
1. Unless otherwise specified, vertical motors shall be full voltage with a Type P base specifically designed for vertical installation. Universal position motors are not acceptable. Vertical motors shall have solid shafts, unless otherwise specified. Vertical motors shall conform to either Type 1 or Type 2 motor requirements as specified under Paragraph 2.4.C., above. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.

G. Conduit Boxes:
1. CAUTION: External conduit boxes on motors shall be sized to accommodate oversized feeder conductors and as shown on the Drawings shall, in any case, not be less than one size larger than NEMA standards. The conduit boxes shall be diagonally split and rotatable in 90 degree steps. A gasket shall be furnished between the conduit box and frame. Motor leads shall be stranded copper wire, Class H or better insulated, non-wicking, with permanent identifications spaced 1-1/2-inches maximum. Clamp type grounding terminals shall be provided in the conduit boxes.

H. Lifting Eyes:
1. Motors weighing more than 50 pounds shall be fitted with at least one lifting eye.

I. Current Imbalance:

1. Current imbalance shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system.
   a. Under five horsepower: Ten percent
   b. Five horsepower and above: Ten percent
2. Imbalance criteria shall be based upon the lowest value measured.

2.5 PRODUCT DATA

A. The following information shall be provided for each motor in accordance with the individual equipment specification.
   1. Motor outline, dimensions and weight.
   2. Manufacturer's general descriptive information relative to motor features.
   3. Where a winding overtemperature device is required, provide a response curve for the temperature device.
   4. Applicable operation and maintenance information specified in Section 01 78 23, Operation and Maintenance Data. Provided overhaul instructions for each motor five HP and over.

2.6 ACCEPTABLE PRODUCTS

A. The following manufacturer's motors generally meet the class and performance requirements of this specification when furnished with appropriate modifications and additional features as specified:
   1. General Electric Inc.
   2. US Motors (Nidec)
   3. Siemens

PART 3 - EXECUTION

3.1 GROUNDING AND BONDING

A. Verify the circuit ground cable (green) is identified and connected to the grounding lug terminal in the conduit box.
B. Provide supplementary grounding by installing a bond from the motor frame to the grounding electrode system as indicated on the drawings.

3.2 FIELD TESTING

A. Verify breather/drain fittings have been installed as specified herein.

B. Provide winding insulation resistance testing for motors to be witnessed by owner or engineer before connection is complete. Winding insulation resistance shall be not less than 10-megohm measured with a 1000-VAC megohmmeter at 1-minute at or corrected to 40-degree C.

C. Provide motor phases current imbalance testing to be witnessed by owner or engineer.

+ + END OF SECTION + +

SECTION 43 28 13

ELECTRIC MOTORS LARGER THAN 250 HORSEPOWER

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes alternating current induction motors that are larger than 250 horsepower. They require the additional features or criteria specified. Unless specified otherwise, electric motors shall be provided by the manufacturer of the driven equipment under an assumption of unit responsibility. The CONTRACTOR shall assign unit responsibility to the manufacturer for the equipment specified and a certificate of unit responsibility shall be provided. This Section refers to motors by enclosure type as defined in NEMA MG 1, except as noted.

B. Horsepower Rating:
   1. Motor horsepower ratings noted in individual equipment Specifications are estimates only and it is the responsibility of CONTRACTOR to furnish motors, electric circuits, and other equipment of ample horsepower capacity to operate the equipment furnished without exceeding the manufacturer's nameplate full-load current at rated manufacturer's nameplate voltage. Full-load current information shall be furnished with the individual submittals

1.2 QUALITY ASSURANCE

A. General: Motors shall be built in accordance with UL 674, UL 1004, NEMA Standard MG 1, and to the requirements specified.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   1. AFBMA 9: Load Rating and Fatigue Life for Ball Bearings.
   2. AFBMA 11: Load Ratings and Fatigue Life for Roller Bearings.
   3. IEEE 112: Standard Test Procedures for Polyphase Induction Motors and Generators.
   4. IEEE 841: Standard for Petroleum and Chemical Industry - Totally Enclosed Fan Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP.
   5. NEMA ICS 2: Industrial Control Devices, Controllers and Assemblies.
   6. NEMA ICS 6: Enclosures for Industrial Controls and Systems.
   7. NEMA MG 1: Motors and Generators.
   8. NEMA MG1-31: Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable- Frequency Controls or Both.

9. UL.674: Electric Motors and Generators for Use in Class I Division I Hazardous Locations
10. UL 1004: Electric Motors.

C. Factory Tests: The motors larger than 250 horsepower shall be subject to the manufacture's complete factory dynamometer tests per IEEE Standard 112 Appendix-B
   1. Standard routine factory tests.
   2. Full Load Heat Run.
   3. Temperature Rise at full load.
   4. Breakdown Torque.
   5. Rated Full Load Slip.
   6. Speed-Torque Curves.

D. Warranty:
   Motors greater than 250 horsepower shall be warranted against defects in materials and workmanship for a period of 5 years under the specified uses and with normal operation and service. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor during the first 60 months of operation.

E. Unit Responsibility: Assign Unit Responsibility as specified in Section 11 00 00, General Equipment Provision, to the manufacturer for the equipment specified in this Section. A Certificate of Unit Responsibility shall be provided.

1.3 SUBMITTALS

A. Submittals shall include the following:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole.
      a. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
      b. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications.
      c. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacture completed IEEE Standard 841 Date Sheet for AC Squirrel Cage Induction Motors with required factory data of motors supplied.
   3. Speed-Torque curve per 1. 2 C Factory Tests.
   4. Factory Test Data: Including Guaranteed Minimum Efficiency for 115% load, 100% load, 75% load, 50% load, and no load.

5. Guaranteed vibration level when measured per MG 1, Figure 7-6:
   a. Displacement: 0.0025 inch peak-to-peak
   b. Velocity: 0.10 inches per second peak
   c. Acceleration: 1g (gravity) peak.
6. Motor heating curve for motors per 1.2 C Factory Tests.
7. Motor outline, dimensions, and weight.
8. Manufacturer's descriptive information relative to motor features.
9. Response curve where a winding over-temperature device is required.
10. For all inverter duty motors: Manufacturer's certification that the motor is compatible with the adjustable frequency drive to be used.
11. Disassembly and repair documentation.

1.4 POWER SUPPLY VARIATIONS

A. Motors shall operate successfully under running conditions at rated load with +/- 10-percent of rated voltage with rated frequency or +/- 5-percent of rated frequency with rated voltage.

1.5 AMBIENT CONDITIONS

A. Unless specified otherwise, motors shall be suitable for continuous operation at an elevation of approximately 1,000 feet above mean sea level. Motors to be installed outdoors, exposed to the weather, shall be suitable for continuous operation in a 50° C ambient temperature; motors to be installed indoors shall be suitable for continuous operation in 50° C ambient temperature, unless otherwise noted.

1.6 NEMA WINDING TEMPERATURES

A. NEMA MG 1 Table 12-7 motors insulation system maximum winding temperatures in degrees-Centigrade (C), with the degrees-Fahrenheit (F) insulation system class specified herein.
   1. Forty degree-C ambient (104 degree-F) is the basis for temperature rise.
   2. For 50 degree C ambient (122F) and above, refer to the driven equipment specifications for additional requirements.

Insulation System Class	Degrees C / F	Temperature Rise by Resistance
A	140 / 284	NA
B	165 / 329	B-rise: 40 + 80 = 120 Degrees C / 248 F
F	190 / 374	F-rise: 40 + 105 = 145 Degrees C / 293 F
H	215 / 419	H-rise: 40 + 125 = 165 Degrees C / 329 F

1.7 NEMA MOTOR TEMPERATURE PROTECTION TYPES

A. The NEMA design shall limit the temperatures of the windings without using a thermal device:
   1. Type-1: Winding Running and Locked Rotor Over-temperature Protection.
   2. Type-2: Winding Running Over-temperature Protection.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S NAMEPLATES

A. Factory installed manufacturer's nameplates shall be stainless steel with embossed or pre-printed lettering and fastened to the motor frame with Type 316 stainless steel pins. Manufacturer's nameplates shall have stamped on them the motor manufacturer's name, design voltage; number of hertz and phase; horsepower rating; amperage and temperature rise at rated load, full load speed, NEMA code letter, service factor, minimum guaranteed efficiency, model number, AFBMA bearing number, serial number and maintenance manual number in accordance with NEMA MGI-10.40.1.

B. A separate factory installed manufacturer's nameplate shall provide lubrication instructions and a separate nameplate connection diagram for dual voltage motors.

C. Additionally, factory to provide the following information on manufacturer's nameplates or additional manufacturer's nameplates for:
   1. NEMA guaranteed minimum efficiency.
   2. Explosion-Proof motors: Indicate UL frame temperature limit code.
   3. Space heater information.
   4. NEMA MG 1 Over Temperature Protection Type Number.
   5. Temperature device rating and alarm and shutdown setpoint information.

D. Thermal Protection:
   1. Provide NEMA Type-1 thermal protection: Two-100-ohm platinum RTDs in each winding.
   2. Provide Resistance Temperature Detectors (RTD) wired to separate motor termination box with wiring diagram provide.
   3. CONTRACTOR shall provide RTD monitor and transmitter at the motor, as indicated or at the motor controller.
   4. Motor manufacturer shall provide indicated alarm and temperature trip setpoints in the O & M manual.
   5. See section 43 25 00 for additional motor protection and monitoring requirements.

2.2 CONSTRUCTION

A. Unless specified otherwise, all motors provided under this Section shall have the following features of construction and operation:

1. Motor voltage, speed and enclosures are specified in the detailed equipment Specifications. Motors furnished with equipment shall comply with this Section.
2. All motors shall be of the motor manufacturer's premium energy-efficient design, different from manufacturer's standard product through the use of premium materials, design and improved manufacturing process, that reduces motor losses approximately 40 percent from standard efficient designs.
3. Motor efficiency shall be determined in accordance with NEMA Standard MG1-12.54.1 and guaranteed minimum full load efficiency labeled on motor manufacturer's nameplate in accordance with NEMA Standard MG1-12.54.2 or MG1-10.40.1 below.
4. All motors shall successfully operate under power supply variations in accordance with NEMA MG1-14.30.
5. All motors shall be NEMA Design B with torque and starting currents in accordance with NEMA MG1-12.35 and 12.37, except in special applications requiring higher starting torques where NEMA Design C is permitted.
6. All motors shall have a 1.15 service factor. Polyphase integral horsepower motors shall be sized so that, under maximum load conditions imposed by the driven equipment, for the conditions specified, the motor manufacturer's nameplate rated horsepower and Class B temperature rise will not be exceeded. Motors with a service factor of 1.15 shall be selected for operation within their full load rating without applying the service factor.
7. Each motor shall be of the speed and horsepower specified or required to properly operate the driven equipment, torque characteristics as required by the drive load and suitable for direct coupling or V-belt drive, as shown on the Drawings and specified herein. Motors shall be designed for full voltage starting, unless otherwise specified.
8. Frames shall be of corrosion-resistant cast iron with integrally cast feet or bases. End bells, conduit box and cover and bases shall be cast iron, with precision machined bearing fits, ASTM Type A-48, Class 25 or better. UL approved automatic stainless steel breather drains shall be provided in the lowest part of front and back brackets to allow drainage of condensation on TEFC and explosion proof motors.
9. Each stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.
10. Insulation materials shall be non-hygroscopic and meet or exceed Class H definition, utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests. Motor temperature rating shall not exceed Class B temperature limits as measured by resistance method when the motor is operated at full load at 1.0 service factor continuously in a maximum ambient temperature of 50° C. Windings shall be copper.
11. Rotor cages shall be fabricated copper. Shafts shall be made from carbon steel.
12. Rotors on frames 213T and above shall be keyed shrunk or welded to shaft and rotating assembly dynamically balanced to NEMA limits in accordance with MG1-12.06. Balance weights, if required, shall be secured to the rotor resistance ring or fan blades by rivets. Machine screws and nuts are prohibited. The entire rotating assembly between bearing inner caps shall be coated with a corrosion-resistant epoxy.

13. Bearings shall be ball, open, single row, deep groove, Conrad type, and shall have a Class 3 internal fit conforming to AFBMA Std. 20. For belted duty applications, drive end bearing may be cylindrical roller type. Bearings shall be selected to provide L-10 rating life of 100,000 hours minimum. Calculations shall be based on external loads using NEMA applications limits in accordance with MG1-14.41 and typical sheave weights and internal loads defined by the manufacturer, including magnetic pull and rotating assembly weight.
15. Motor lubrication system shall consist of a sealed bearing or a grease inlet on motor bracket with capped grease fitting on inlet, grease relief plug 180 degrees from inlet, grease reservoir in bracket and grease reservoir in cast inner cap. Motor shall be greased by manufacturer with a premium moisture resistant polyuria thickened grease containing rust inhibitors and suitable for operation over temperatures from -25° C to 120° C. Vertical motors lubrication system shall be manufacturer's standard oil or grease.
16. All bolt and cap screws shall be of high strength, SAE Grade 5 zinc-plated and chromatic steel. Screwdriver slot fasteners are unacceptable.
17. All motor parts including frame, brackets, fan cover and terminal box shall receive a minimum of two coats of high grade USDA accepted epoxy paint. Motor assembly shall successfully withstand salt spray tests for corrosion in accordance with ASTM B-117 for 96 hours.
18. All motors shall be painted the same color as the driven equipment.
19. Standard motors shall be provided by the manufacturer of the driven equipment under an assumption of unit responsibility. The CONTRACTOR shall assign unit responsibility to the manufacturer for the equipment specified and a certificate of unit responsibility shall be provided.
20. Where shown on the Drawings or Schedules, furnish motors with space heaters to prevent condensation inside the motor enclosure after motor shutdown and maintain the temperature of the winding at not less than 5-degree C above outside ambient temperature. Heaters shall be flexible wraparound type rated 120 volts, single phase, 60 Hertz. The space heater rating in watts and volts shall be noted on the motor manufacturer's nameplate or on a second manufacturer's nameplate. Space heater leads H1 and H2 shall be brought to a separate terminal block or pigtails in the motor conduit box or separate conduit box with a threaded conduit opening

2.3 ADDITIONAL REQUIREMENTS FOR MOTORS LARGER THAN 250 HP

A. General:
   1. Unless otherwise specified, motors over 250 horsepower shall be three phase, squirrel cage, full voltage start induction type. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment's starting torque requirements.

B. Rating:
   1. Unless otherwise specified, motors shall be rated for operation at 460 volts, 3 phase, 60 Hz, and shall be continuous time rated in accordance with NEMA Standard MG 1, Paragraph 10.35.
   2. Motors for variable frequency systems shall not be required to deliver more than 80 percent of the motor's service factor rating by any load imposed by

the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

C. Enclosure and Insulation:
   1. General: Motors shall be classified as Type 1 (Process) or Type 2 (Explosion proof). Enclosures and insulation systems shall be as specified in the following paragraphs. Temperature rise for all motor types shall not exceed that permitted by Note II, Paragraph 12.42, NEMA MG 1. The insulation shall be non-hygroscopic.
      a. Type 1 Motors (Process): Type 1 motors shall be premium energy efficient motors, totally enclosed, fan cooled. All motors shall have Class H insulation with Class B temperature rise. Motors shall conform to IEEE 841. All internal surfaces shall be coated with an epoxy paint. Motors shall be rated for corrosive atmosphere duty.
      b. Type 2 Motors (Explosion proof): Explosion proof motors shall be UL listed in accordance with UL 674 for Class I, Group D hazardous atmospheres. The motor shall have Class H insulation and shall conform to IEEE 841. Steel frame motors will not be permitted. A UL-approved Type 316 stainless steel breather/drain device shall be provided in the motor drain hole. The motor shall be provided with a frame temperature thermostat which meets the UL frame temperature limit code T2A (280°C). The thermostat shall contain an automatically reset, normally closed contact rated two amperes at 115 volts AC.

D. Motors for Variable Frequency Drives:
   1. Motors intended for use with variable frequency drives shall be compatible with the characteristics of the intended variable frequency inverters. Motors shall be Type 1 or Type 2 as specified in the detailed Specification. Insulation for all motors operating with variable frequency drives shall be Class H with Class B temperature rise. Variable frequency drive motors shall be premium energy-efficient motors. Motors shall be capable of withstanding a pulse voltage of at least 1750 volts with a rate of rise up to 750V/micro second. The motors shall be certified by the manufacturer as suitable for inverter duty.
   2. All motors connected to variable frequency drives shall be equipped with shaft grounding rings. Shaft grounding devices must be factory installed or installed by a reputable motor shop with the expertise in the proper installation of the devices. If the shaft grounding devices are not factory installed, a third party shall be engaged to test the installation to ensure no damaging shaft currents are present.

E. Minimum Manufacturer's Nameplate Efficiency: Motor minimum manufacturer's nameplate efficiency, determined in accordance with IEEE 112B testing procedures, when operating on a sinusoidal power source shall conform to the following for motors 250-500HP. For motors above 500 horsepower, efficiency shall be determined by customized motor specification questionnaire (see NTS) in consultation with the manufacturer:

IEEE STD 841-2001	900 rpm 8-pole	1200 rpm 4-pole	1800 rpm 6-pole	3600 rpm 2-pole
250HP				
600V	93.6	94.1	94.1	94.5
2300/4000V	94.1	94.1	94.1	94.1
300HP				
600V	-	94.1	94.5	94.5
2300/4000V	94.1	94.1	94.1	94.1
350HP				
600V	-	94.1	94.5	94.5
2300/4000V	94.1	94.1	94.1	94.1
400HP				
600V	-	-	94.5	94.5
2300/4000V	94.1	94.1	94.1	94.1
450HP				
600V	-	-	94.5	94.5
2300/4000V	94.1	94.1	94.1	94.1
500HP				
600V	-	-	94.5	94.5
2300/4000V	94.1	94.1	94.1	94.1

F. Vertical Motors:
   1. Unless otherwise specified, vertical motors shall be full voltage with a Type P base specifically designed for vertical installation. Universal position motors are not acceptable. Vertical motors shall have solid shafts, unless otherwise specified. Vertical motors shall conform to either Type 1 or Type 2 motor requirements as specified under Paragraph 2.4.C., above. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.

G. Conduit Boxes:
   1. CONTRACTOR is cautioned that external conduit boxes on motors shall be sized to accommodate oversized feeder conductors and as shown on the Drawings shall, in any case, not be less than one size larger than NEMA standards. The conduit boxes shall be diagonally split and rotatable in 90 degree steps. A gasket shall be furnished between the conduit box and frame. Motor leads shall be stranded copper wire, Class H or better insulated, non-wicking, with permanent identifications spaced 1-1/2-inches

maximum. Clamp type grounding terminals shall be provided in the conduit boxes.

H. Lifting Eyes:
1. Motors weighing more than 50 pounds shall be fitted with at least one lifting eye.

I. Current Imbalance:
1. Current imbalance shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system.
a. Under five horsepower: Ten percent
b. Five horsepower and above: Ten percent
2. Imbalance criteria shall be based upon the lowest value measured.

2.4 PRODUCT DATA

A. The following information shall be provided for each motor in accordance with the individual equipment specification.
1. Motor outline, dimensions and weight.
2. Manufacturer's general descriptive information relative to motor features.
3. Where a winding overtemperature device is required, provide a response curve for the temperature device.
4. Applicable operation and maintenance information specified in Section 01 78 23, Operation and Maintenance Data. Provided overhaul instructions for each motor.

2.5 ACCEPTABLE PRODUCTS

A. The following manufacturer's motors generally meet the class and performance requirements of this specification when furnished with appropriate modifications and additional features as specified:
1. General Electric Inc.
2. Emerson US Motors
3. Siemens
4. Flygt (for submersible pumps)

PART 3 - EXECUTION

3.1 GROUNDING AND BONDING

A. Verify the circuit ground cable (green) is identified and connected to the grounding lug terminal in the conduit box.

B. Provide supplementary grounding by installing a bond from the motor frame to the grounding electrode system as indicated on the drawings.

3.2 FIELD TESTING

A. Verify breather/drain fittings have been installed as specified herein.

B. Provide winding insulation resistance testing for motors to be witnessed by owner or engineer before connection is complete. Winding insulation resistance shall be not less than 10-megohm measured with a 1000-VAC megohmmeter at 1-minute at or corrected to 40-degree C.

C. Provide motor phases current imbalance testing to be witnessed by owner or engineer.

+ + END OF SECTION + +

SECTION 44 31 21.23
INORGANIC BIOFILTER

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide labor, equipment, materials and incidentals as required to furnish, install, check, test, document, startup and place in satisfactory operation a fully functional new replacement Biofilter Odor Control System as shown in the drawings and as specified herein.
2. The related work for the Biofilter Odor Control System shall include, but not be limited to the following:
   a. Odorous air ductwork and supports from the wet well to the biofilter inlet air plenum.
   b. Work necessary to provide all air plenum and all Biofilter media components.
   c. Air header distribution system consisting of plastic flooring support systems, screen and biofilter gravel layers.
   d. Biofilter soil media
   e. Odorous air fan
   f. Pre-Humidification system consisting of in duct spray nozzle
   g. Perimeter Sprinkler system with controls.
   h. Spare parts recommended by biofilter media supplier.
   i. Laboratory analysis, development and supply of the soil biofilter media and gravel air plenum materials.
   j. Oversight of biofilter installation and operator training.
   k. Performance testing of the completed installation.
   l. All necessary appurtenances for a complete and properly functioning soil bed biofilter odor control system.

B. Related sections include but are not necessarily limited to:
1. Division 00 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 01 – General Requirements
3. Section 40 10 15 – Fiberglass Reinforced Plastic Duct and Accessories

1.2 SUBMITTAL

C. Drawings and Data:
1. A marked up copy of this specification is to be included showing any proposed exceptions or deviations from the specified requirements.
2. Dimensioned detailed biofilter plan and sections showing the HDPE raised flooring system layout to create the air plenum under the biofilter media. Drawing to show how the flooring system fits into the proposed concrete vessel.
3. Make, model, weight, and horsepower of each equipment assembly.

4. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
5. Performance data for the fan including curves showing pressure, capacity, horsepower demand, and efficiency over the entire operating range and from shutoff to maximum capacity.
6. Detailed drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.
7. Manufacturer's information on the soil biofilter media and gravel support media.
8. Details on spray nozzle and irrigation systems.
9. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
10. Power and control wiring diagrams, including terminals and numbers.
11. Shop and Field Painting Systems: Include manufacturer's descriptive technical catalog literature and specifications.
    a. To include corrosion protection methods for exposed concrete in the biofilter.

D. Quality Control Submittals:
   1. Submit performance test certificates and reports during installation. This is to include verification that the soil and gravel media is suitable for the corrosive odor control application.

E. Performance Test Submittals:
   1. Submit a Detailed Performance Testing Plan which includes:
      a. Test equipment and apparatus.
      b. Calibration and setup procedures.
      c. The specific testing methodology to be used.
      d. The sampling and analysis procedures.
   2. Submit a final report that provides a narrative of the sampling activities, a copy of the original sample log, photographs showing the locations of the velocity measurements, tabular summary of the data, calculated results, and conclusions of these results.

F. Operations and maintenance manual.

1.3 SYSTEM SUPPLIER EXPERIENCE REQUIREMENTS

G. System Supplier Experience Requirements:
   1. The System Supplier must have a minimum of five (5) soil bed biofilter installations of similar size, or larger, that have successfully operated to control the odors associated with hydrogen sulfide, organic sulfur compounds, and other malodorous compounds associated with a municipal wastewater treatment plant.
   2. These installations must have been in operation for a minimum of three (3) years.

3. Successful operation will be defined as having operated within the original performance criteria for the life of the installation without requiring a media replacement.

1.4 WARRANTY

A. The System Supplier shall warrant the useful life of the activated soil biofilter medium for a period of at least 10 years and the System Supplier shall also warranty there will be no nuisance odors detectable a distance of 30 feet beyond the edge of the biofilter bed. If any defects or malperformance occurs in that period, the System Supplier must make all necessary alterations, repairs, or replacements at no additional cost to the Owner.

PART 2 – PRODUCTS

1.2 ACCEPTABLE MANUFACTURERS

A. Design, testing, and all components of the soil bed biofilter odor control system shall be provided by a single supplier who shall have sole-source responsibility for the performance of the system. The inorganic biofilter layout and dimensioning as shown on the drawings has been based around the inorganic biofilter as manufactured by Bohn Biofilter corporation. Acceptable System Suppliers:
   1. Bohn Biofilter Corporation, Tucson, Arizona.

1.3 DESIGN CRITERIA

A. The biofilter odor control system shall be installed as generally shown on the Drawings.

B. Service Conditions: The biofilter system shall be designed to incorporate provisions to meet the following service conditions:
   1. Ambient Temperature Ranges: 32° to 120°F.
   2. Precipitation: Approximately 9.0 inches per year.
   3. Altitude: Approximately 1000 feet above mean sea level (MSL).

C. The biofilter system shall be designed to treat 3,700 scfm of continuously ventilated air. This system shall be designed to eliminate odorous compounds from the airstream typical of a municipal wastewater treatment facility. These compounds shall include, but not be limited to, hydrogen sulfide, mercaptans, reduced sulfur compounds, ammonia, and volatile organic compounds typical of this type of application.

D. The biofilter design shall utilize an inorganic soil bed type media. Compost, wood chips, and other types of organic media will not be acceptable.

E. The maximum allowable pressure drop from the outlet of the fan to discharge through the entire depth of the biofilter media shall be 7.5 inches of water column (WC).

1.4 ODOR LOADING

A. Anticipated odor loading will include hydrogen sulfide and other reduced sulfur organic based odorants as follows:
   1. H2S average 5 ppm with peaks to 20 ppm
   2. Reduced sulfur organic based compounds such as methyl mercaptan, dimethyl sulfide, dimethyl disulfide, carbonyl sulfide and carbon disulfide totaling to 0.5 ppm on average with peaks to 1 ppm

1.5 PERFORMANCE CRITERIA

A. Removal Efficiency:
   1. Hydrogen Sulfide: A 99 percent removal rate for concentrations above 10 ppmv. A 100 ppb maximum discharge concentration at inlet concentrations less than 10 ppmv.
   2. Olfactory Performance: The biofilter shall emit no nuisance odors and have no detectable odors within a distance of thirty (30) feet downwind of the bed.

B. Media Life: The activated soil medium and the gravel support medium shall have a minimum useful life of twenty (20) years. “Useful life” shall be defined to mean operation under the following conditions: no detectable degradation in the odor removal performance of the biofilter when operated and maintained in accordance with the System Supplier’s written operations and maintenance requirements. The biofilter soil media and gravel layers supported by a Hahn Plastic Biofilter flooring system creating an air plenum zone will likewise be covered in the warranty.

1.6 BIOFILTER VESSEL

A. The biofilter will be inside a concrete cast in place vessel as shown in the drawings.

B. The concrete is to be protected against corrosion attack by means of a protective coating systems such as:
   1. Tnemec Series 218 Epoxy liner with Tnemec Series 435 Perma-Glaze top coating or
   2. Carboguard 510 Primer with Carboguard Plasite 4500 S top coating

1.7 BIOFILTER MEDIA

A. The biofilter layering shall be as generally shown in the drawings including:
   1. A top layer 5 feet deep in soil media providing at least 90 seconds empty bed residence time at the rated air flow.
   2. A gravel support layer nominally 4 to 6 inches thick under the soil media
   3. A screen supporting the gravel and soil media
   4. A plastic flooring systems supporting the media and creating a lower air plenum zone.
   5. Headloss of all components at rated design flow shall be included in the total headloss requirements of the odor control fan as outlined in this section.

B. Activated Soil Medium:
   1. The media shall be as tested and approved by the System Supplier.
   2. Media development; blending, amendment components and quantities, and laboratory analysis, shall be the responsibility of the System Supplier.
   3. The media shall be delivered moist; if stockpiled greater than 1 week, the Contractor shall make efforts to wet the material. Media shall be placed in a uniform manner that will prevent aggregation and compaction of materials, and prevent displacement of the air piping.

C. Gravel Bedding Material
   1. Unfrozen, friable, and no clay balls, roots, or other organic material.
   2. Clean and washed 20 mm rock for drainage.
   3. Graded to a depth as indicated on the drawings.
   4. The geomembrane liner shall be manufactured and installed as per System Supplier and manufacturer's recommendations.

D. Activated Soil Filter Medium
   1. System Supplier shall be responsible for supplying, blending, and delivering the soil filter media to the construction site. System Supplier shall provide oversight of placing the media in the filter bed.
   2. Hard, rounded sand with average specific gravity not less than 2.0 (a.k.a. washed concrete sand).
   3. Gradation: ASTM C33.
   4. Activated soil media shall be imported material or a combination of materials, and meet the grading requirements of the System Supplier. For purposes of locating a source of media, the media shall generally conform to the following:

US Sieve Size	Percent Passing
No. 4	95-100
No. 8	40-70
No. 50	10-20
No. 100	0-5
No. 200	0-5

1.8 PLASTIC AIR PLENMUM

A. The biofilter gravel and soil media will be supported by a plastic flooring system.
   1. This is a plastic flooring system designed for the full weight of the biofilter media during operation as well as surface traffic by loaders during media placement activity.

B. Flooring system is to be a HDPE raised floor style as generally shown in the Drawings. Detailed floor layouts are to be provided as part of the submittal process.

C. The raised floor system is to be topped by a flooring screen selected by the biofilter media supplier. The flooring system, screen and support gravel are to be selected by the biofilter supplier and shown as suitable for exposure to the anticipated odor causing compounds and the biological activity in the biofilter media. Exposure the corrosive gases and acid byproducts are to be considered.

D. Manufacturer:
   1. Hahn Biofilter Raised Flooring Systems
   2. Or equal.

1.9 HUMIDIFICATION SYSTEM

A. The biofilter system shall include a pre-humidification system for the vapor stream. The humidification system shall operate continuously and shall include an isolation valve, rotameter, a wye strainer, unions, and spray nozzle assembly. The spray nozzle assembly is to be located in the Exhaust Fan discharge piping as shown in the drawings and is to be detailed in the Shop Drawing submittal for review.

B. The spray nozzle assembly shall consist of spray nozzles mounted on a removable lance. The assembly shall be removable from the odorous air piping for inspection and maintenance without disassembly of the piping system.

C. The spray nozzle shall provide fine spray atomization in a hollow cone pattern using hydraulic pressure alone. The nozzle shall be constructed of 316 stainless steel and shall have an integral strainer.
   1. Flowrate: 0.40 gallons per minute.
   2. Water Pressure: 40 psig.
   3. Manufacturer:
      a. Bete Fog Nozzles, Inc., Model P48.
      b. Or equal.

1.10 SPRINKLER SYSTEM

A. The biofilter system shall also include a perimeter sprinkler system for moisture control of the activated soil media. The sprinkler system shall include a sprinkler nozzle, sprinkler timer, solenoid control valve, and control panel.

B. The layout of the sprinkler system and the number of sprinkler system zones shall be determined by the System Supplier as generally shown in the drawings.

C. Sprinkler Nozzle: The sprinkler nozzles shall be a full or part-circle sprinkler. The sprinkler shall be a Rain Bird, Model 5500 Plus sprinkler, or equal. The sprinkler shall have an effective radius of 32 feet at 40 psi water pressure.

D. Control Valve: The sprinkler control valve shall be a Rain Bird PESB scrubber valve. Valve shall be supplied with 24V ac coil and fail closed on a loss of power.

E. Sprinkler Control System: The sprinkler control system shall consist of a Rain Bird Model ESP8LXME sprinkler timer. Electrical input required: 120 VAC ± 10%, 60 Hz or 220V ± 10%, 50 Hz. Electrical output: 24-26.5 VAC.

1.11 PARTICULATE GREASE FILTER/DEMISTER

A. General:

1. Units shall be designed and selected for continuous operation with air containing corrosive vapors and gases generated from treatment and conveyance of municipal wastewater.
2. Vapors and gases may be expected to include hydrogen sulfide, other low level reduced sulfur organic odorous compounds, airborne grease, particulates including potential insects, and water saturated air.
3. Suppliers must be able to show similar field experience.
4. Acceptable Manufacturers
    a. Daniel Mechanical
    b. ECS
    c. Or equal

B. Operating Requirements:

1. Pressure Drop: Maximum of 0.5 IN WC.
2. Particulate Droplet Removal: 99 percent greater than or equal to 40 microns.

C. Equipment Features:

1. Consists of two-stage filter pads housed inside FRP enclosure.
    a. First Pad: Woven Type 316L stainless steel for grease and particulate filtration.
    b. Both layers removable for cleaning by side door access as shown in the drawings.
2. FRP Housing:
    a. Fire rated vinyl ester FRP matching ductwork
        1) Provide removable door to allow removal and replacement of filter pads.
            a) With 316 hinges and clamps
        2) Transitioned and flanged for installation in foul air ductwork per drawing space limitations.
        3) Bottom of the housing to include a channel directing captured moisture to drain
        4) Housing to be provided integral stainless steel base supports provided by vessel supplier.
        5) Alternatively, the housing shall have two 6-IN diameter FRP legs. Length of legs shall be coordinated with the contactor. Housing shall be supported by these legs independent of the connecting ductwork, anchored to the concrete base pad with stainless steel Hilti bolts.
3. Differential pressure gauge with tubing and fittings to measure pressure drop across unit. Locate gauge to be easily accessible and readable in the field.
4. Drain: U-trapped 2-IN drain connection with ball valve.
5. Flanges: Drilled with neoprene gaskets

D. Odorous Air Fan Performance Requirements:

1. Provide 1 fan: one duty
2. Fan should be Underwriters Laboratories (UL) listed.
3. Capacity:
    a. 3700 scfm
4. Fan Rated Maximum Pressure Ratings:
    a. Total: 10.5 IN WC.
    b. Vacuum: 2 IN WC.
    c. Discharge Static Pressure: 8.5 IN WC.
    d. Fan should be able to shutdown automatically if an excessive pressure situation is encountered.
5. Fan will be VFD driven and must run stable under the following conditions:
    a. Design condition 3700 cfm at 10.5 inches w.c.
    b. Submittals are to show fan curves showing the fan and VFD can run over the full range from the design condition and if turned down to 50% rpm.

E. Acoustical Levels:

1. Broad spectrum weighted average Fan noise levels for ducted fans should not exceed a radiated sound power level above 79 dba with a ducted inlet and outlet when measured at 3 FT distance.

F. Provide backwardly inclined wheel of non-overloading design, pulley driven FRP fan with adjustable sheaves.

G. Fan shall be FRP, centrifugal type with backward-inclined blades on the impeller, single-inlet/single-width, industrial fiberglass fan with arrangement shown in the drawings. Fan shall be rated and constructed in accordance with AMCA standard test code for centrifugal fans.

H. Fiberglass construction shall conform to ASTM D4167 product standards. Fan resin shall be suitable for exposure to the specified service conditions. Resin shall have a Class I flame spread rate of 25 or less. Exterior shall have UV protective gel coat. Outside or exposed surfaces shall be resin-rich, reinforced with a nexus veil. A certificate from the resin manufacturer listing the nomenclature, composition, and characteristics of the resin shall be furnished with the fans.

I. Configuration:

1. Housings: Fiberglass reinforced with rigid bracing to increase structural integrity.
2. Curved scroll design with 1 IN NPT drain connection at the bottom of the scroll.
3. Flanged nozzles on intake and outlet.
4. Fan supplier to provide inlet and outlet fan transition pieces, flexible connections, and isolation damper.
5. Fan Shafts: Solid stainless steel Type 316. Fan shall have self-aligning grease-packed bearings, with neoprene shaft seals and OSHA approved weatherproof FRP motor/drive cover.
6. Steel mounting frame for fan and motor.
7. Flanged flexible connectors for the fan inlet and discharge. Open spring vibration isolators with neoprene waffle base pads top and bottom selected for 1.5 IN deflection.
8. Factory install sheaves and drive belts for 150 percent of the design condition.
9. Spark resistant design with graphite embedded FRP and grounding wires.

J. Drive Type: Variable speed, v-belt driven.

1. Drive Motor:
    a. All electrical motors shall be TEFC and premium efficiency, conforming to the applicable portions of Specification Section 01 61 03. Provide Three Phase 480 Volt Electric Motors. Motors must be suitable for installation in a Class 1, Division 2, Group D environment. Drive motor shall be at least 20 horsepower. Sized for VFD operation.
    b. Provide OSHA compliant motor drive system covers.

K. Fan Support: Fan support to include a steel base provided by the fan supplier.

1. General arrangement of the support system shall be as shown on the Drawings and as described herein.
2. Structural Steel Base: A rigid structural steel base for the support of fan including fan bearings; and fan drive components including motor and v-belt.
    a. Vibration isolator brackets shall be welded to the perimeter frame.
    b. Vibration Isolators.

1) Vibration isolator shall be the free standing spring type sized to provide minimum 1 IN deflection under the dead loads due to the foul air fan, fan accessories and structural steel.

c. Finishing: Prime and finish coat mounting frame for fan and motor in accordance with Specification Section 09 90 00.

L. Manufacturers:

1. Verantis Environmental Solutions Group, CLUB
2. New York Blower, Fume Exhauster.
3. Or Equal.

1.12 FRP DUCTWORK

A. Provide FRP ductwork and accessories per Specification Section 40 10 15.

PART 2 - EXECUTION

2.1 BIOFILTER INSTALLATION

A. General:
1. Elevations shall be surveyed at the biofilter floor, top of plenum zone, and top of soil media to establish correct slope and correct thickness of each layer.

2.2 PLACING SOIL/GRAVEL MATERIALS

A. Placement Into Bed:
1. Plenum zone gravel layer shall be placed on a raised flooring system. The liner will be placed between the concrete floor and raised flooring system. The raised floor has a screen above the grates with the gravel above the screen and the media directly above the gravel.
2. Air plenum gravel shall be leveled and undisturbed prior to soil media placement. Do not permit workers to walk or stand directly on soil media; use boards that will sustain workers' weight without displacing materials.
3. Use placement devices as approved by System Supplier; for example front end loaders, excavators, and/or concrete conveyors.

B. Hot Weather:
1. Make provisions for windbreaks, shading, fog spraying, sprinkling, wet cover, or other means to maintain media with a wet surface.
2. Addition of chemical wetting agents or other additives are not allowed.

2.3 BIOFILTER TESTING

A. Functional Testing:

1. Test all system components for proper adjustment and operation. Adjust as necessary.
2. Provide certification of functional acceptance prior to commencing performance testing.

B. Performance Testing:
   1. General:
      a. To demonstrate that the biofilter system furnished hereunder is installed and performs in accordance with the provisions of these Specifications, the System Supplier shall conduct a 120 hour (1 work week) performance test in accordance with an approved testing protocol. The performance test shall not commence until a test plan has been received and approved, and the functional testing has been completed.
      b. Successful testing must include uninterrupted operation during the 1 week run period with one day dedicated to taking field measurements for pressure, air flow, and H2S odor removal performance testing.
      c. The System Supplier shall provide, install, and maintain, if required, all temporary metering or analytical equipment necessary to measure the various performance parameters.
      d. The System Supplier shall inform the Engineer at least 14 days prior to the start of any performance testing. The Engineer shall have the right to observe, sample, and make any parallel determinations during the performance test.
      e. Within 10 days after the conclusion of the test period, the System Supplier shall submit a Performance Test Report, including all laboratory and field test data, stating the conclusions of the test with regard to the performance criteria.
   2. Test Conditions:
      a. The biofilter shall have been fully functional and receiving odorous air from the facility for a minimum of 14 consecutive days prior to commencing the testing.
      b. All testing, adjusting, and balancing shall have been completed and approved.
   3. Sampling and Data Measurement: During the test period, at a minimum, the following data and measurements shall be taken at the frequency indicated:
      a. Fan airflow rate: Initially.
      b. Fan inlet and discharge pressure in inches of WC: Initially.
      c. Unit airflows (cfm/ft^2) shall be taken at four (4) locations across the biofilter; two corners and two equally spaced locations in the interior of the bed. These measurements shall be taken before gas sampling.
      d. Hydrogen sulfide concentrations (ppb) at the inlet to the biofilter: Every hour.
      e. Hydrogen sulfide concentrations (ppb) at two locations on the biofilter bed using a flux chamber: Every hour. The results will then be calculated by:

1) Percent Removal = (Average Inlet – Average Outlet)/Average Inlet
Note: percent Removal only comes into play when the biofilter inlet sample's concentrations of hydrogen sulfide are greater than 10 ppmv. For concentrations less than 10 ppmv, all Average Biofilter Outlet samples must be less than 100 ppbv to meet performance verification requirements.

f. A photographic record of the sampling technique and bed sampling location will be completed for each type of sampling.
g. Sampling Log: A sampling log shall be maintained that will include:
1) A hand-drawn map showing the approximate locations of all bed sampling locations.
2) Date, time, location, sampler, and results of each sample.
3) A description of each photograph taken.
4) Weather conditions for the sampling day.
5) A description of any exceptions from the sampling plan.
h. Hydrogen Sulfide Sampling: Hydrogen sulfide sampling shall be completed using a Jerome Analyzer with a detection limit of 1 ppbv. The analyzer shall be operated in compliance with the manufacturer's instructions. A copy of the instructions shall be submitted with the final report. The results of the hydrogen sulfide sampling shall be recorded in the sampling log.

4. Sprinkler system.
a. Sprinkler system changes submit diagram.
b. Description or photos taken.
c. Sprinkler timer and control valving and sequencing.
d. Soil media moisture: date time location of sample taken; including results if satisfactory for the operation of the biofilter.

2.4 MANUFACTURERS' SERVICES

A. A representative for the System Supplier specified herein shall be present at the jobsite for the minimum period listed for the services hereinunder, travel time excluded:
1. System supplier shall supervise placement of media.
2. Three days for installation assistance, inspection, and certification of the installation. Provide certificate.
3. Two days for functional testing, operator training, and performance testing.

2.5 MANUFACTURERS' CERTIFICATE(S)

A. Provide manufacturers' certificate(s) of proper installation.

END OF SECTION

SECTION 46 33 11
CHEMICAL FEED - LIQUID SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chemical metering pumps for:
      a. Ferrous Chloride
   2. System accessories.
   3. Liquid chemical tanks:
      a. Storage tanks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 05 73 – Specialty Valves and Appurtenances
   3. Section 40 05 73.25 – Piping Specialties and Accessories
   4. Section 40 61 93 – Process Control System Input I/O List

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Secure and coordinate entire system including but not necessarily limited to metering pumps, electric equipment, controls, hardware, valving, and piping through the metering pump manufacturer.

1.3 SYSTEM DESCRIPTION

A. System shall be supplied through a single source and include all components specified herein.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Drawings and product data:
      a. See Specification Section 01 33 23.10.
      b. Pump:
         1) Chemical resistance data for materials used.
         2) Complete performance information:
            a) Capacity, operating range.
            b) Pressure rating.
            c) NPSH required.
            d) Stroke speed, length.
            e) Horsepower required.
            f) Plunger diameter.
      c. Valves:
         1) See Specification Section 40 05 73
      d. Piping:
         1) See Specification Section 40 05 73.25

e. Control modes.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 PROJECT CONDITIONS

A. Pumped Liquid:

LIQUID	SPECIFIC GRAVITY	TEMP DEGF
Ferrous Chloride	1.18-1.4 @ 20 degree C	85-120

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Metering pumps and accessories:
      a. Hydra-Cell
      b. Or, Approved Equal.
   2. Tanks:
      a. Storage tanks:
         1) USP Technologies
         2) Or, Approved Equal

B. Submit request for substitution in accordance with Specification Section 01 33 23.10.

2.2 METERING PUMPS

A. Materials:
   1. Diphgram pump:

Pumping Unit	Material
Pump Head	Non-metallic
Check Valves Seats/O-ring Balls	 Viton Ceramic
Diaphragm	Hypalon or Neoprene, TFE faced
Fittings	PVC
Case	Metal or ABS

B. Pump Performance and Design Requirements
   1. Units shall have the following characteristics:
      a. Chemical: Ferrous Chloride
      b. Maximum Capacity/head (gpm): 3.00
      c. Electrical requirements: 4-20mADC process signal with 120 VAC power.

C. Pump Fabrication:
   1. Pump:

a. Ball-check inlet and outlet valves.
b. Moving parts totally enclosed and self-lubricating.
c. Complete external control with 10:1 minimum manual stroke adjustment, adjustable while operating.
d. Capable of operating dry without damage to any component.
e. Repeatable accuracy: 1 PCT of maximum output or better.
f. Nameplate with chemical, capacity (gph) and pressure (psi) ratings.

2. Support:
a. Mount pump and drive on common support plates.
b. Fabricate to withstand all operating loads.
c. Provide anchorage of support.

3. Controls:
a. Solenoid pumps:
1) ON-OFF switch with local speed control (0-100 PCT) and 4-20 mA input signal.
b. Motor drive:
1) ON-OFF switch with SCR drive with 20:1 range. Local manual speed control or 4-20 mA input signal.

D. Spare Parts:
1. Recommended by the Chemical feed system provider.

2.3 SYSTEM ACCESSORIES

A. Provide each accessory listed for each metering pump as recommended by the manufacturer.
1. Calibration chamber:
a. PVC, graduated in ml.
b. Size:
1) Pumps up to 20 GPH: 500 ml.
2) 20 to 40 GPH: 1,000 ml.
3) Pumps above 40 GPH: 4,000 ml.
c. Include isolation ball valve.
2. Pressure Regulator or Relief valve:
a. PVC with TFE or hypalon with TFE facing diaphragm.
b. External pressure setting.
c. Sized for pump capacity.
d. Pipe discharge to supply tank.
3. Pulsation dampener:
a. Wetted components: PVC.
b. Sized for 5 PCT variation from average pressure.
c. Provide stainless steel pressure gage, 2.5 IN DIA dial, glycerine-filled and gas fill valve.

2.4 TANKS

A. General:
1. Mixer loads: For tanks having a mechanical mixer, coordinate mixer dead or live loads.
2. Uplift:
a. For tanks with concrete pad-mounting system, the anchoring system shall be designed for uplift forces caused by flooding in the chemical containment area.

b. The storage tank shall be assumed to be empty with liquid chemical level outside the tank equal to top of containment wall.

3. Tank materials and resins to be resistant to chemicals.

B. Storage Tanks:
1. General:
a. Concentration:
1) 32 percent.
b. Shape: Vertical, flat bottom on concrete pad, dome-type top.
c. Ambient temperature: 25-120 DEGF.
d. Material: High Density Linear Polyethylene (HDLPE) – cross linked and one piece seamless construction with UV Inhibitor
e. Nominal capacity:
a) Ferrous chloride storage tank: 7800 GAL.
f. Approximate dimensions:
1) Diameter
a) Ferrous chloride storage tank: 11.75 FT.
g. Height: 176-1/4 IN.

C. Tank Accessories:
1. General:
a. Radar type level sensor
1) Endres Hauser or approved equal
b. Location and size of piping connections as shown on Drawings.
c. Penetrations to be factory installed in accordance with referenced standards.
d. Pipe connections to be flange type.
2. Storage tanks:
a. The following minimum trim features to be included:
1) Fill port.
2) Overflow port
3) Lifting lug
4) Leak inspection port
5) Inverse level indicator
6) Drain port, side bottom type.
7) Suction port.
8) 24 IN DIA top manhole, quick-access type.
9) Mushroom type vent.
10) Side ladder attached to tank.
11) Fill pipe and conduit support attachment lugs.
12) All tank ports to be flange type. 2” Sch. 80 flange for level sensor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 01 71 23 – Installation of Equipment

3.2 DEMONSTRATION

A. See Specification Section 01 75 16 – Equipment of System Startup and

Performance Testing

+ + END OF SECTION + +

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