City of Phoenix

LIFT STATION 47
CIVIL & ELECTRICAL IMPROVEMENTS
WS90400079

TECHNICAL SPECIFICATIONS
VOLUME 2 of 3
Divisions 1-17

FINAL SUBMITTAL
February 2018
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SECTION 01110

SUMMARY OF WORK

PART 1 - GENERAL

1.1 LOCATION AND DESCRIPTION OF WORK

A. The Work is located on the site of Lift Station 47 at 4102 N. 113th Avenue, in Phoenix, Arizona.

B. The Contract Documents include the following:
   1. Volume 1 of 3 Division 0 Specifications
   2. Volume 2 of 3 Divisions 1 through 17 Specifications.

C. The Contract Documents for the Work to be performed include the following, but are not limited to:
   1. Bringing the discharge piping above grade; replacing the entire electrical line-up, including ATS, SES, outdoor MCC, RTU and PLC; regrading the site to allow the gates to open fully; replacing the existing conex with an office building; replacing the existing odor scrubber with a biofilter with appurtenances.

D. Hazardous Environmental Condition: The responsibility for clean-up of Hazardous Environmental Conditions, in which conditions are described in reports referenced in the Supplementary Conditions, is within the Scope of Work, belongs to CONTRACTOR and shall be coordinated with the General Conditions, Supplementary Conditions and Section 01413, 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. Not Used.
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 01320, Progress Schedule.

B. Incorporate the requirements of Section 01143, 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, still achieve the required objective and maintain the same or greater level of treatment. The ENGINEER’S determination on the acceptability of any alternative sequence from that shown or specified shall be final.

C. CONTRACTOR: The project electric motor requirements, specified in Section 11000, Electric Motors, do not allow standard "off the shelf" motors. Make provisions in sequence and progress of Work to account for longer manufacturing and delivery lead times for the motors and equipment requiring electric motors under this project.

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. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to 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. On Private Property: The work to be performed on the project site is on property owned by the City of Phoenix.

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 notified 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, except the following items which shall remain OWNER'S property:
   1. Facility staff will review removed equipment and components to be salvaged under item "C". The contact person is: Richard Garcia (602.495.7748).

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 ++
SECTION 01111

SCHEDULE OF COMPLETION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commence the Work promptly upon the date established in the Notice to Proceed and shall pursue it to completion in accordance with the Agreement (Section 00500) as described in this Section.

B. The Schedule of Completion describes selected project components only and is not intended to describe all project Work or constraints, interrelationships, or sequentially required Work.

C. Contract times, as well as liquidated damages for failure to Substantially Complete the Schedule of Completion specified in this Section, are defined in the Agreement (Section 00500).

1.2 SCHEDULE OF COMPLETION

A. Submit Shop Drawings in accordance with Section 01332, Shop Drawing Procedures, and the individual specification Sections. Submit early Shop Drawings as noted and as required to meet the Schedule of Completion.

B. The Schedule of Completion for the Lift Station No. 47 Civil & Electrical Improvements Project shall be as follows:

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01140

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 the Lift Station 47 site. Confine storage of materials and support facilities to designated areas located within the Lift Station 47 site.
   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 01550, Access Roads and Parking Areas. 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. Promptly repair damage to premises caused by construction operations. Upon completion of the Work, restore premises to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01143

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 Facility and all essential services and facilities are maintained operational throughout the construction period.

B. The sequences of Work and Schedule of Completion are specified under Section 01110, Summary of Work, and Section 01111, Schedule of Completion. The sequences have been assembled to maintain plant 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 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 any treatment process, compromise security, create potential hazards to operating equipment and facility personnel, interrupt pumping 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 facility operating requirements.

D. Work not specifically covered in Section 01110, Summary of Work; and Section 01111, Schedule of Completion or in the following paragraphs may, in general, be done at any time 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. 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 operations and processes by limiting the number of shutdowns required.

G. Not shut-off or disconnect any operating system of the facility, unless approved by the ENGINEER, in writing. All 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 02220, Demolitions, 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. Responsible for supplying all temporary odor control, 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 facility during construction activities. All pumps shall be provided with flowmeters. 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 30 days prior to the commencement of the Work.

1.2 GENERAL CONSTRAINTS

A. Article 1.3, and Section 01111, Schedule of Completion, below specify the sequence and shutdown durations, where applicable, for facility 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 facility site.
   1. Load limits on Access Roads: Existing and new underground facilities, such as electrical duct banks, pipelines, etc., in, under and crossing facility roads, shall be protected.
   2. Access to Facility Site: Maintain access for City Operations Personnel to perform work, while the facility is under construction.
   3. Safety Barriers: Place safety barriers around unsafe areas located around operational areas accessible to Personnel.
   4. Personnel Access: 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. Storm drainage: Storm drainage on the site shall be operational at all times,
unless otherwise specified in Article 1.3, below.

7. 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.

8. 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.

9. Draining Force Main:
   a. Unless otherwise specified, the contents of the force main undergoing
      modifications shall be transferred to the wet well 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. Remove spillage by other method such as
      Vactor truck, as approved by the ENGINEER.

10. 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.

11. 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.

12. Schedule all start-ups for Monday through Thursday. No start-ups will be
    allowed on Friday, Saturday, and Sunday.

13. The adjacent neighbors to the site need to be notified 72 hours in advance of
taking the temporary odor control system out of service. Notify OWNER
and ENGINEER 14 days in advance of taking the temporary odor control
system out of service, and note the time duration the system will be out of
service for.

14. The existing piping, appurtenances, shade structure, and concrete slabs
cannot be removed until the CONTRACTOR completes asbestos and lead
testing and provides results to the OWNER for approval to begin the
demolition. All asbestos and lead testing results must remain on site at all
times during construction activities.
1.3 SHUTDOWNS

A. General:

1. A shutdown shall be defined as a portion of the normal operation of a facility 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 facility 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 30 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 one 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 facility 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 facility 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. 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 facility 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 OWEN and shall be performed in accordance with the General Conditions. Make no claims for extra compensation as a result thereof.

1.5 MAINTENANCE OF PLANT OPERATIONS SCHEDULE

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

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

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 facility operations.

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

F. Is advised that Work in multiple areas of the facility, 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 ++
### Preliminary List of MOPOs

<table>
<thead>
<tr>
<th>ITEM NO./ DWG. NO.</th>
<th>ITEM DESCRIPTION</th>
<th>PROCESS UNITS OPERATING PRIOR TO SHUTDOWN</th>
<th>PROCESS UNITS OPERATING DURING SHUTDOWN</th>
<th>PROCESS UNITS OUT-OF-SERVICE DURING SHUTDOWN</th>
<th>IMPACT ON OTHER PROCESS UNITS</th>
<th>PROCEDURE</th>
<th>CONSTRAINTS AND REMARKS</th>
<th>DURATION OF SHUTDOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Take the force main and pumps out of service to install bypass piping.</td>
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<tr>
<td>2</td>
<td>Take odor scrubber out of service and install biofilter</td>
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<tr>
<td>3</td>
<td>Transitioning Electrical</td>
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### Activity Schedule

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<tr>
<th>Line</th>
<th>Description</th>
<th>Party</th>
<th>Sign Off</th>
<th>Date</th>
<th>Start By</th>
<th>Complete By</th>
<th>Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Submit MOPO for Owner's review and approval</td>
<td>Contractor</td>
<td></td>
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<tr>
<td>Note</td>
<td>HAZCOM Training is required prior to starting MOPO</td>
<td>Contractor</td>
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<tr>
<td>2</td>
<td>Site walk with approved MOPO to verify all equipment and materials are onsite</td>
<td>Contractor, Owner, Engineer</td>
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<tr>
<td>3</td>
<td>Install bypass pumps in wet well and connect bypass piping to pumps</td>
<td>Contractor</td>
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<tr>
<td>4</td>
<td>Shut down both pumps; lockout tag out; notify COP Collection O&amp;M Group, Security, and SCADA</td>
<td>Owner &amp; Contractor</td>
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<tr>
<td>Note</td>
<td>The Owner will assist with lockout and the Contractor will need to provide locks</td>
<td>Contractor</td>
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<tr>
<td>5</td>
<td>Hold open check valves and drain force main back to wet well</td>
<td>Contractor</td>
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<tr>
<td>6</td>
<td>Connect bypass piping to force main</td>
<td>Contractor</td>
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<tr>
<td>Note</td>
<td>Pumping truck may be required for haul off, while the connection is being made</td>
<td>Contractor</td>
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<tr>
<td>7</td>
<td>Construct new piping and get it ready to connect to force main</td>
<td>Contractor</td>
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<tr>
<td>Note</td>
<td>Bypass pumps are to remain in service until electrical improvements have been installed and the testing period is complete</td>
<td>Contractor</td>
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<tr>
<td>8</td>
<td>During the night, drain force main and bypass piping back to wet well; connect bypass piping; connect new discharge piping to force main</td>
<td>Contractor</td>
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<tr>
<td>9</td>
<td>Bring pumps back in service and notify COP Collection O&amp;M Group, Security, and SCADA. Test pumps for process tests and alarms.</td>
<td>Owner</td>
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<tr>
<td>10</td>
<td>Remove bypass pumps and bypass piping from the project site after new piping has been in service approximately 4 weeks.</td>
<td>Contractor</td>
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</tbody>
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### Emergency Contacts

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<tr>
<td>Contractor</td>
<td></td>
<td></td>
<td><a href="mailto:msikes@carollo.com">msikes@carollo.com</a></td>
</tr>
<tr>
<td>Owner</td>
<td>Melanie Sikes, Project Manager</td>
<td>480.296.1229</td>
<td></td>
</tr>
<tr>
<td>Owner</td>
<td></td>
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<tr>
<td>Engineer</td>
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</table>
City of Phoenix Water Services Department Maintenance of Plant Operations (MOPO)

Design No.: WS90400023-1  Date MOPO Submitted: 
Project Name: Lift Station 47 Civil & Electrical Improvements  Start Time/Date: 
Construction No.: WS90400079  End Time/Date: 
Site: Lift Station 47  Walk Through Date: 
Address: 4102 N. 113th Ave  Contractor: 

**MOPO Activity:** Take odor scrubber out of service and install biofilter

**MOPO No.:** 2  (Draft)

**MOPO Written By:** BT & MRS

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
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<td>Site walk with approved MOPO to verify all equipment and materials are onsite</td>
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<tr>
<td>3</td>
<td>Shut down and lockout tag out existing scrubber equipment</td>
<td>Owner</td>
<td></td>
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<tr>
<td>4</td>
<td>Connect temporary odor control system</td>
<td>Contractor</td>
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<tr>
<td></td>
<td>The temporary odor control system will need to be coordinated with City Operation Staff for coordination with the air quality permit</td>
<td>Contractor</td>
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<tr>
<td>5</td>
<td>Acid wash and rinse the system. Decommission scrubber and media. Tanks are approximately 900 gallons each. Demolish existing odor scrubber system.</td>
<td>Contractor</td>
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<tr>
<td>6</td>
<td>Construct biofilter</td>
<td>Contractor</td>
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<tr>
<td>7</td>
<td>Disconnect the temporary odor control system and connect the biofilter to existing foul air duct</td>
<td>Contractor</td>
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<tr>
<td>8</td>
<td>Remove temporary odor control system from the site after the biofilter system has gone through complete testing (approximately 3 weeks)</td>
<td>Contractor</td>
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</tbody>
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**Emergency Contacts**

<table>
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<tr>
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<tbody>
<tr>
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<tr>
<td>Engineer</td>
<td>Melanie Sikes, Project Manager</td>
<td>480.296.1229</td>
<td><a href="mailto:msikes@carollo.com">msikes@carollo.com</a></td>
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**City of Phoenix Water Services Department Maintenance of Plant Operations (MOPO)**
### City of Phoenix Water Services Department Maintenance of Plant Operations (MOPO)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Responsibility</th>
<th>Schedule</th>
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</thead>
<tbody>
<tr>
<td>Line</td>
<td>Description</td>
<td>Party</td>
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<td>1</td>
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<td>Contractor</td>
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<tr>
<td>2</td>
<td>Site walk with approved MOPO to verify all equipment and materials are onsite</td>
<td>Contractor, Owner, Engineer</td>
</tr>
<tr>
<td>3</td>
<td>Notify COP Collection O&amp;M Group, Security, and SCADA to shut down and lockout service entrance section.</td>
<td>SRP, Owner &amp; Contractor</td>
</tr>
<tr>
<td>4</td>
<td>Construct new electrical, instrumentation and controls and put back in service</td>
<td>Contractor</td>
</tr>
<tr>
<td>5</td>
<td>New system to be inspected</td>
<td>Contractor, Owner, Engineer</td>
</tr>
<tr>
<td>6</td>
<td>Notify SRP, COP Collection O&amp;M Group, Security, and SCADA that the electrical transfer is complete.</td>
<td>Contractor</td>
</tr>
<tr>
<td>7</td>
<td>Test the electrical system, instruments, controls, and alarms</td>
<td>Contractor</td>
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</tbody>
</table>

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</table>
SECTION 01271

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, facility 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. 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. Pay Application: Refer to Section 01331, Reference Forms.
1.4 GENERAL

A. Bid Item 1 - Miscellaneous Site Work (i.e. Bollards, yard hydrants, guard rail, manhole adjustments, gate work, check backflow preventor, ribbon curb, splash blocks, and all work under the Bid Documents except those Bid Items listed separately below):
   1. Measurement and Payment: The lump sum payment for Bid Item 1 will be full compensation for completing the Work, as shown and specified. Not included in Item 1 are Items 2 through 16.

B. Bid Item 2 - Mobilization/Demobilization:
   1. Measurement and Payment: The lump sum payment for Bid Item 2 will be full compensation for CONTRACTOR'S mobilization/demobilization costs.

C. Bid Item 3 - Environmental Program and Permitting Costs:
   1. Measurement and Payment: The lump sum payment for Bid Item 3 will be full compensation for CONTRACTOR'S Environmental Program and Permitting as defined in the Bidding Documents.

D. Bid Item 4 - Demolition:
   1. Measurement and Payment: The lump sum payment for Bid Item 4 will be full compensation for demolition.

E. Bid Item 5 - Remove and Replace Asphalt Pavement:
   1. Measurement and Payment: The lump sum payment for Bid Item 5 will be full compensation for removal and replacement for asphalt pavement.

F. Bid Item 6 - Decomposed Granite:
   1. Measurement and Payment: The lump sum payment for Bid Item 6 will be full compensation for decomposed granite.

G. Bid Item 7 - Structural Concrete Slabs and Supports:
   1. Measurement and Payment: The lump sum payment for Bid Item 7 will be full compensation for structural concrete slabs and supports.

H. Bid Item 8 - Electrical Shade Canopy:
   1. Measurement and Payment: The lump sum payment for Bid Item 8 will be full compensation for the electrical shade canopy.

I. Bid Item 9 - Office/Restroom Building:
   1. Measurement and Payment: The lump sum payment for Bid Item 9 will be full compensation for the office/restroom building complete in place.
J. Bid Item 10 - Painting/Coatings:
   1. Measurement and Payment: The lump sum payment for Bid Item 10 will be
      full compensation for paintings and coatings.

K. Bid Item 11 - Yard Piping:
   1. Measurement and Payment: The lump sum payment for Bid Item 11 will be
      full compensation for yard piping.

L. Bid Item 12 - Biofilter and Appurtenances:
   1. Measurement and Payment: The lump sum payment for Bid Item 12 will be
      full compensation for the biofilter and appurtenances.

M. Bid Item 13 - Electrical, Instrumentation and Controls:
   1. Measurement and Payment: The lump sum payment for Bid Item 13 will be
      full compensation for electrical, instrumentation and controls.

N. Bid Item 14 - Allowance for Utility Power (SRP):
   1. Measurement and Payment: The allowance payment for Bid Item 14 will be
      full reimbursement based on approved invoices for costs associated with
      providing utility power from SRP.

O. Bid Item 15 - MOPOs Including Bypass Pumping:
   1. Measurement and Payment: The lump sum payment for Bid Item 15 will be
      full compensation for all MOPOs including bypass pumping.

P. Bid Item 16 - Allowance for Unforeseen Conditions:
   1. Measurement and Payment: The allowance payment for Bid Item 16 will be
      paid as approved by the Engineer at the extension of existing bid prices,
      negotiated price, or time and material, as determined by the Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01291
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 01329, Progress Schedule, shall be used as the basis for preparing progress payments. The Schedule of Values may be used as a basis for negotiations, concerning additional work or credits, which may arise during the construction. Quantities and unit prices shall be included in the schedule, when approved by or required by the ENGINEER.

D. The Preliminary Schedule of Values and Schedule of Values itemized list of Work, for each major part of the Work and division of Work shall be grouped under the following index areas identified in Section 01271, Measurement and Payment.

E. The Schedule of Values shall include an itemized list of Work for all Maintenance of Plant Operations (MOPO) Work as specified in Section 01143, Coordination with OWNER'S Operations. Itemized MOPO Work shall be included within applicable major Work area.

1.2 PREPARATION

A. The Preliminary Schedule of Values:
   1. Preliminary Schedule of Values shall show all Work under the index areas listed in Paragraph 1.1.D., above.
   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 item is allotted to the cost of Shop Drawing preparation, Operation and Maintenance Manuals, Testing and Training. 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 01330, Submittals, 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 and Extra Unit quantities.

15. The Schedule of Values shall be prepared to a level of detail equal to or greater than required by the Supplementary Conditions.

16. The Schedule of Values shall be coordinated with the Resource/Cost Loading of the Progress Schedule provided in Section 01322, Progress Schedule (Cost Loaded CPM).

1.3 SUBMITTALS

A. Submit two copies of the Preliminary Schedule of Values to ENGINEER for review within 14 days after the Notice to Proceed.

B. Submit two copies of 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 ++
SECTION 01301

PRE-CONSTRUCTION CONFERENCE

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 14 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. 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.

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, be prepared to discuss all of the following; but 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.
10. Schedule of values.
11. Processing and Schedule of Payments.
12. Use of premises.
13. CONTRACTOR responsibility for safety and first aid procedures.
15. Housekeeping.
16. Field Offices.
17. Maintaining Record Drawings.
18. Letter of Notice to Proceed.
19. Permits.
20. Emergency Telephone Numbers.
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 ++
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.

C. Not be responsible for damage done by contractors not under CONTRACTOR'S jurisdiction. 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. It is the duty of the CONTRACTOR to determine that all necessary permits have been obtained. The CONTRACTOR, at his own expense, 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 01320

PROGRESS SCHEDULE (BAR CHART)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Project Schedule which conforms to the requirements below.

B. Schedule Updates shall be submitted every month until issuance of Certificate of Substantial Completion.

1.2 CONTENT

A. List all major, long lead or critical equipment, or material to be ordered, indicating:
   1. Shop Drawing submittal dates and required approval dates.
   2. Product delivery dates.
   3. Factory and field testing dates.

B. Dates for beginning and completing each phase of the Work by activity and by trades.

C. Milestones.

1.3 FORMAT

A. Bar chart:
   1. Bar chart diagram shall show:
      a. Activity ID.
      b. Activity Description.
      c. Early Start and Early Finish dates.
      d. Original and Remaining Durations.
      e. Responsibility Codes.
      f. Logical flow of activities with respect to each other.
      g. Time Scale shall indicate the first date in each work week.
      h. Sheet size shall be 24-inches by 36-inches, or 11-inches by 17-inches, or as accepted by the ENGINEER.
      i. Title block shall include project, revision number, and date on each page.

B. Organization:
   1. Group shop drawing submittals and reviews into a separate sub-schedule.
   2. Group product deliveries into a separate sub-schedule.
   3. Group construction work into a separate sub-schedule by activity.
C. Activities:
   1. Activity Identification (ID) Numbers:
      a. Each activity shall have a unique ID number. It shall consist of letters, numbers, or any alphanumeric combinations.
      b. Preceding activities shall have lower numbers; succeeding activities shall have higher numbers.
      c. Activity Description shall clearly describe work location and phase or staging.

D. Activity Durations:
   1. Expressed in full working days.
   2. Limitation on duration of an activity shall be ten (10) working days except for procurement of long lead materials or equipment.

1.4 SUBMITTALS

A. Initial Submission package shall include three (3) sets labeled "Baseline Schedule".
   1. Submit for review within ten (10) calendar days of Notice to Proceed.
   2. No change from accepted Baseline Schedule will be permitted without written consent of the ENGINEER.

B. Monthly Updates:
   1. Schedule Updates shall be as of the end of each month, or as directed by the ENGINEER, and submitted within five (5) work days.
   2. Submit a narrative report:
      a. A listing of all changes made to each schedule update.
      b. Discussion of problems causing delays, anticipated length of delays, and proposed countermeasures.

C. Submittal of Updates:
   1. Transmit to the ENGINEER three (3) copies of each submittal set for review.
   2. Supplementary updates, such as recovery schedules and delay claims, shall be submitted, in addition to monthly updates, when directed by the ENGINEER, at no additional cost to the OWNER.

D. Software:
   1. Baseline Schedule and monthly schedule updates shall be submitted on compact disc "CD" or other media approved by the ENGINEER. Each CD or media shall be appropriately labeled with its content and date of preparation.
   2. Use scheduling software such as "Microsoft Project", "Primavera Products", or as accepted by the ENGINEER.

E. All schedule submittals shall be made to the ENGINEER, unless specified otherwise.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01323

CONSTRUCTION PHOTOGRAPHS

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 maximum number of color digital photographs required will be 1,000.

B. Take a minimum of ten (10) color digital photographs 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 five (5) overall general project photographs depicting the over all 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. A minimum of five (5) color digital photographs will be taken each time the photographer is at the site.
1.3 PRINTS

A. Furnish one print and one CD with digital files for each photograph to the ENGINEER with each Monthly Progress Payment.

B. Furnish additional photographs or prints requested by ENGINEER at cost. Maximum number photographs required will be 25.

C. Provide high quality 5-inch by 7-inch standard weight prints with a satin finish.

D. 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.

E. 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.

F. 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.

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 CONTRACTOR's responsibility to provide pre-construction photographs and video, so as to resolve any disputes which may arise regarding the considerations prior to and subsequent to construction, belongs to CONTRACTOR.
   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 two (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 01330

SUBMITTALS

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 30 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. Submittals within 14 days after the Notice to Proceed: 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 01331, Reference Forms.
   1. Preliminary Schedule of Shop Drawings and Sample Submittal in accordance with the General Conditions and Section 01332, Shop Drawing Procedures.
   2. Preliminary Progress Schedule: Prepare and submit in accordance with Section 01320, Progress Schedule.
B. Submit within 30 days after the Notice to Proceed: Submit the following items within 30 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 01331, Reference Forms.
   1. Submittal Schedule: Prepare and submit schedule of all Shop Drawings in accordance with Section 01332, Shop Drawing Procedures.
   2. Monthly payment schedule.
   3. Maintenance of Plant Operations Schedule, in accordance with Section 01143, Coordination with OWNER'S Operations.
   4. Ninety-day Bar Chart Schedule: Prepare and submit a 90-day Bar Chart Schedule within 10 days, in accordance with Section 01320, Progress Schedule.

C. 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 01331, Reference Forms.
   1. Progress Schedule: Prepare and submit a Progress Schedule within 14 days, in accordance with Section 01320, Progress Schedule.

D. Submit the following items at the Pre-construction Conference: Refer to Sections 01332, Shop Drawing Procedures.

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

F. 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 01320, Progress Schedule.
   2. Shop Drawings, Product Data and Samples: Submit Shop Drawings, product data and samples in accordance with Section 01332, 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 01331, Reference Forms, shall be submitted with each progress payment.
   4. Request for Information: Submit a Request for Information (RFI), included in Section 01331, 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 three hard copy and one 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 01331, 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 01331, 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 01331, 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 01331, Reference Forms. After the Work Change Directive has been accepted by the OWNER, a Change Order included in Section 01331, Reference Forms, will be prepared and executed. 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 01331, 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 01331, 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 01331, 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 01331, 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 01323, Construction Photographs.

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 01781, Operation and Maintenance Data and Section 01821, 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 01785 – PREVENTIVE MAINTENANCE DATA.

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

H. 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 01782, Record Documents.

2. Guarantees, Warranties, and Bonds: Submit as required in the General Conditions and listed in various Sections of the Specifications, and Section 01781, 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 01781, Operation and Maintenance Data.

4. Survey notes.

5. Construction photographs of all completed Work, in accordance with Section 01323, Construction Photographs.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01331

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.

<table>
<thead>
<tr>
<th>Form No.</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>01143-A</td>
<td>Extended Construction Work Hours Permit Application</td>
</tr>
<tr>
<td>01330-A</td>
<td>Schedule of Values</td>
</tr>
<tr>
<td>01330-B</td>
<td>Shop Drawings, Product Data and Sample Submittal Schedule</td>
</tr>
<tr>
<td>01330-C</td>
<td>Authorized Signatures Form</td>
</tr>
<tr>
<td>01330-D</td>
<td>Application for Payment</td>
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<tr>
<td>01330-E</td>
<td>MBE/WBE Utilization Form</td>
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<tr>
<td>01330-F</td>
<td>Request for Change Order Proposal</td>
</tr>
<tr>
<td>01330-G</td>
<td>Change Order Proposal</td>
</tr>
<tr>
<td>01330-H</td>
<td>Work Change Directive</td>
</tr>
<tr>
<td>01330-I</td>
<td>Change Order Pricing Sheet</td>
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<tr>
<td>01330-J</td>
<td>Change Order</td>
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<td>Request for Information</td>
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<tr>
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<td>Request for Alteration</td>
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<td>01330-M</td>
<td>Contractor’s Daily Construction Report</td>
</tr>
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<td>01330-N</td>
<td>TV Inspection Request</td>
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<tr>
<td>01330-O</td>
<td>Contractor Submittal Review Checklist</td>
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<tr>
<td>01330-P</td>
<td>Submittal Review Form</td>
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<td>01330-Q</td>
<td>Contractors Contingency Usage Request</td>
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<td>01332-A</td>
<td>Submittal Transmittal Form</td>
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<td>Shop Drawing Review Checklist</td>
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<tr>
<td>01415-A</td>
<td>Confined Space Data Sheet</td>
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<td>01415-B</td>
<td>Confined Space Entry Permit</td>
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<td>01415-C</td>
<td>Confined Space Hot Work Permit</td>
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</table>
CITY OF PHOENIX: Water Services Department
PROJECT NAME: LIFT STATION 47 CIVIL & ELECTRICAL IMPROVEMENTS
PROJECT NUMBER: WS90400079

01600-A Equipment Information Form Instructions
01600-A1 Equipment Information Form
01600-B Unit Responsibility Certification Form
01600-C Equipment Manufacturer Vendor Installer Information Form
01620-A Manufacturer’s Installation Certification Form
01620-B Delivery Inspection Form
01752-A Equipment Test Report
01752-B Commissioning Checklist
01752-C Contractors Functional Test Plan
01752-D Emergency Contact Information
01752-E Equipment and Instrumentation Checkout Log
01752-F Instrumentation Calibration Log
01752-G Startup Team
01752-H Test Setup Form
01752-I Test System Group
01781-A Operation & Maintenance Manual Review Checklist
01781-B Operations & Maintenance Manual Data Review Checklist
01783-A Spare Parts Receiver Form
01785-A Preventative Maintenance Data Submittal Form
01821-A Manufacturer’s Instruction Certification Form
01821-B Training Request Form
11000-A Motor Data Form
16215-A Arc Flash Electrical Manufacturer's Equipment Data
16215-B Power Coordination - Arc Flash Labeling Sign-Off Form
17001-A Instrument Tubing Leak Test Form
17001-B Calibration Test Data Form.
17001-C Functional Acceptance Test

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
City of Phoenix
DEVELOPMENT SERVICES DEPARTMENT

Extended Construction Work Hours
Permit Application

City Code Section 23-14 (h) authorizes issuance of permits for extended construction work hours if there is an emergency condition or if the public peace and quiet will not be unreasonably disturbed. A permit is required for any work performed on Saturdays or Sundays throughout the year, for work on weekdays before 7:00 a.m. or after 7:00 p.m. from October 1 through April 30, or for work on weekdays before 6 a.m. or after 7:00 p.m. from May 1 through September 30.

CONDITIONS OF APPROVAL
If application is approved, the following conditions must be met:
A. Construction traffic is limited to major streets. Use of residential neighborhood streets is prohibited.
B. Maximum practical distance shall be maintained between residences and work sites.
C. If a term longer than 30 days is required to complete work, the applicant may request renewal of this permit.
D. This permit may be immediately revoked if unresolved complaints are brought to the attention of the Development Services Department.
E. Special Conditions: ________________________________________________________________

APPLICATION FOR EXTENDED CONSTRUCTION WORK HOURS
Complete Items 1 through 4

1. PROJECT DEVELOPMENT ACTIVITY
   Project Name __________________________
   Project Location ________________________
   Address ________________________________
   Name of On-Site Job Superintendent:
   Phone ________________________________
   Extension Requested For:
   Date From __________ Date To __________
   Day(s) of Week _______________________
   Time(s) of Day ________________________

2. APPLICANT INFORMATION
   Name _________________________________
   Firm/ Organization ______________________
   Address ______________________________
   Phone ________________________________ FAX ______________________
   Email ________________________________
   Applicant’s Signature __________________
   Date _________________________________

3. RATIONALE: PLEASE ATTACH A WRITTEN RATIONALE FOR REQUESTING AN EXTENDED HOURS PERMIT.
   Note: All requests for projects located in or near a residential area must be accompanied by a site plan showing proximity to residents. An approved haul plan and a permit are prerequisites for extended hauling hours.

4. FEES: □ Original - $300 (up to 30 days) □ Renewal - $150 (up to 30 days)

FOR STAFF USE ONLY
   □ Approved □ Approved w modifications □ Denied □ EXTH __________ □ EXTR __________
   Date, Day(s) of Week, Hours ________________________________
   Authorizing Signature ____________________ Phone ____________________ Date __________
   Fee Collected $ ________ Date Paid __________ Receipt # __________
   Project Info: Project # __________ Permit Type/# __________ Qtr Section __________
   Other:
   cc: City Council District
   Police Patrol Division __________________________

Applications will be accepted at 200 West Washington, 2nd Floor, or they may be faxed to the attention of Extended Hours Permit Coordinator at (602) 534-3274

This publication can be made available in alternate formats (Braille, large print, computer diskette, or audiotape) upon request. Contact the Development Services Department at (602) 262-7811 voice or (602) 534-5500 TTY.
Extended Construction Work Hours Permit
Information Sheet

A permit is required for any work performed on Saturdays or Sundays throughout the year, for work on weekdays before 7:00 a.m. or after 7:00 p.m. from October 1 through April 30, or for work on weekdays before 6 a.m. or after 7:00 p.m. from May 1 through September 30.

1. Obtain an Extended Hours Construction Permit application form from the Development Services Department, 200 West Washington, 2nd Floor, Plan Review Reception Area (west side of the 2nd floor). A fillable pdf form may also be obtained on-line at http://phoenix.gov/DEVPRO/extendhrs.pdf.

2. Fill out the application requesting the dates and times you would like to work outside the permissible hours.

3. Provide a reason the work must be done outside the allowable times. Please be specific as this rationale is part of the criteria used to evaluate your request.

4. Your application will be reviewed by a member of the Project Coordination Team. The project coordinator researches whether the location is near a residential development, and whether neighborhood complaints have been received by the Development Services Department or another city department.

5. One of three actions will occur in response to your application.
   - The extended hours permit application may be approved as it is requested.
   - The application may be approved with a modified schedule.
   - The application may be denied.
   
   A response to your request is typically made within two (2) working days of receiving the application. If you are near occupied residences, please allow additional time for research. Moreover, you may be required to create and distribute flyers with contact information before obtaining your permit. A template containing required information is available on the 2nd Floor or by calling the phone number below.

6. After your application has been reviewed, researched and action taken, you will be called. If a permit is granted, you may obtain and pay for your permit at City Hall, Development Services Department Plan Review Reception Office, 200 West Washington, 2nd Floor.

7. A new permit is valid for a maximum of 30 days. The fee for the first permit is $300. An application for renewal may be made following the same process if a renewal application is submitted prior to expiration of the existing permit. The renewal fee is $150, also for a maximum of 30 days. If your permit has expired, the permit fee will be $300.

8. Flyers are required for concrete pours or any other construction work which will disturb the public peace and quiet in or near a residential area. The flyer must contain the following information:
   - Work hours
   - Date of the pour(s)
   - Name and number of a contact person who will be on-site and available to discuss complaints at the time of the construction activity.

   A template is available detailing required information at City Hall, Development Services Department Commercial Reception Office, 200 West Washington, 2nd Floor. One can also be Emailed to you.

9. Subcontractors requesting to work outside the permissible hours must submit a letter of consent from the developer with the application.

Questions may be directed to the Development Services Department at (602) 534-5482.
SCHEDULE OF VALUES

Sheet ______ of _________

Section No. ______________

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Material</th>
<th>Labor</th>
<th>Equipment</th>
<th>Total</th>
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</table>
# Form 01330-B

**SHOP DRAWINGS, PRODUCT DATA AND SAMPLE SUBMITTAL SCHEDULE**

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<tr>
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<th>Description</th>
<th>Specification Section Number</th>
<th>Date To Be Submitted</th>
<th>Approval Needed By</th>
<th>Date Submitted</th>
<th>Date Reviewed</th>
<th>Transmittal Number</th>
</tr>
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</tbody>
</table>
Form 01330-C

AUTHORIZED SIGNATURES FORM
(Corporation)

Gentlemen:

WHEREAS, ____________________________, a(n) (Name of State) ________________________________
Corporation, is required to execute documents which are necessary for the prompt and efficient
execution of the corporate business:

NOW, THEREFORE, BE IT RESOLVED, (by the Board of Directors of the Corporate Name), that
name of parties listed below be authorized to execute and sign on behalf of said corporation the
following documents:

1. The Proposal  6. Change Orders
2. The Contract  7. Application for Payment
3. The Bond  8. Work Change Directives
4. Payrolls  9. All other papers necessary for the
corporation's affairs and the
execution of the contract.

The powers and duties herein granted shall be and is hereby granted for the duration of the contract
for the construction of the          ,
Project No. ___________, or until express notice of revocation has been duly given in writing,
whichever is the lesser period.
Dated and passed by the Board of Directors this ______ day of ______, 20__.

<table>
<thead>
<tr>
<th>NAME</th>
<th>SIGNATURE</th>
<th>TITLE</th>
<th>DOCUMENTS</th>
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</table>

I, ____________________________, of the ________________________________,
a corporation, do hereby certify that the above is a true and correct copy of a resolution adopted by
the Board of Directors of said corporation, at a meeting of said board held on _____________, day
of 20__ , and that the same is in full force and effect at this time.

(Seal of Corporation)

___________________________
(OFFICER OF CORPORATION)

___________________________
(NAME & TITLE)

STATE OF ____________________________________

COUNTY OF ________________________________

This instrument was acknowledged before me this ______ day of ____________, 20 ______
By ____________________________, appearing before the undersigned Notary Public, and stated
that he executed such instrument on behalf of said corporation for the purpose and consideration
therein expressed.

My Commission Expires: ____________________________

NOTARY PUBLIC

February 2018  01330-C  10093D11

pw://Carollo/Documents/Client/AZ/Phoenix/10093D10/Specifications/01330-C (Additional Services FS)
CITY OF PHOENIX: Water Services Department
PROJECT NAME: LIFT STATION 47 CIVIL & ELECTRICAL IMPROVEMENTS
PROJECT NUMBER: WS90400079

Form 01330-D

APPLICATION FOR PAYMENT

To: Project Manager
200 W. Washington Street, 8th Floor
Phoenix, Arizona 85003

Payment Period: From mm/dd/yy to mm/dd/yy

<table>
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<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>CONTRACT AMOUNT</th>
<th>ESTIMATED AMOUNT THIS PERIOD</th>
<th>AMOUNT PREVIOUSLY INVOICED</th>
<th>AMOUNT COMPLETED TO DATE</th>
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<td>$xx,xxx,xxx xx</td>
<td>$xx,xxx,xxx xx</td>
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</tbody>
</table>

ATTACHMENTS: SCHEDULE OF VALUES

GROSS AMOUNT DUE: $xx,xxx,xxx xx

RETAINAGE - 10% $xx,xxx,xxx xx
SECURITIES - 10% $xx,xxx,xxx xx
NET AMOUNT DUE TO DATE: $xx,xxx,xxx xx
LESS AMOUNT PREVIOUSLY PAID: $xx,xxx,xxx xx
AMOUNT DUE THIS APPLICATION: $xx,xxx,xxx xx

CERTIFICATION OF CONTRACTOR: I certify that all items and amounts shown on the face of this Application for Payment are correct, that to the best of my knowledge and belief, all work has been performed and/or material supplied in full accordance with the requirements of the referenced contract, and/or duly authorized deviations, substitutions, alterations, and/or additions; that the foregoing is true and correct statement of the contract account up to and including the last day of the period covered by this Application that no part of the “Amount Due This Application” has been received, and that the undersigned and subcontractors have: (check applicable line).

a. Complied with all labor provisions of said contract.
b. Complied with all the labor provisions of said contract except in those instances where a dispute exists with respect to said labor provisions. (If “b” is checked, include attachment briefly describing nature of dispute.)

Contractor Representative Date
Title

CERTIFICATION OF ENGINEER: I certify that all work described was inspected, and that to the best of my knowledge and belief the work was performed and/or supplied in full accordance with the requirements of this contract.

Resident Project Representative Date

CERTIFICATION OF PROJECT MANAGER/ENGINEER: I certify that I have checked and verified the above and foregoing Application for Payment; that to the best of my knowledge and belief it is a true and correct statement of work performed and/or material supplied by the contractor; that all work and/or material included in this Application has been inspected and that it has been performed and/or supplied in full accordance with the requirements of the referenced contract; and that payment claimed and requested by the Contractor is correctly computed on the basis of work performed and/or material supplied to date.

Project Manager/Engineer Date
Firm

February 2018

01330-D-1

10093D11
### CITY OF PHOENIX
WATER SERVICES DEPARTMENT

### CONTINUATION OF APPLICATION FOR PAYMENT

#### PROGRESS PAYMENT NO. 1

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Project Name</th>
<th>Contract No.</th>
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<th>ESTIMATED AMOUNT THIS PERIOD</th>
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# Form 01330-E

CITY OF PHOENIX EQUAL OPPORTUNITY DEPARTMENT  
CONTRACTOR'S MONTHLY STATEMENT OF MBE/WBE UTILIZATION

**CONTRACTOR:** ____________________________  **PAY REQUEST NO.:** __________  **REPORT PERIOD FROM:** ________________ to ________________

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<th>Project Description:</th>
<th>Base Bid Amount: $</th>
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<tr>
<th>M/WBE Business Name and Telephone Number</th>
<th>MBE or WBE</th>
<th>Original Contract Amount</th>
<th>Contract Adjustments</th>
<th>Revised Contract Amount</th>
<th>AMOUNT EARNED THIS PERIOD</th>
<th>AMOUNT EARNED TO DATE</th>
<th>Amount Retained this Period</th>
<th>Amount Retained to Date</th>
<th>Percentage Completed to Date</th>
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Minority Owned Business Enterprise Totals  
Woman Owned Business Enterprise Totals

Authorized Signature: ____________________________  Date: ____________________________

Name and Title: ____________________________

FOR CITY OF PHOENIX USE

Percent of total project complete _________ %  Date: __________________

City Project Manager ____________________________  Signature
REQUEST FOR CHANGE ORDER PROPOSAL

Date: ______________

CONTRACTOR _________________________________

___________________________________________

Project Name ___________________________________

Project No. _____________________________________

Change Order No. ________________

NOTICE TO CONTRACTOR: Please submit a Change Order Proposal for the proposed modifications to the Contract Documents as described below. If acceptable, a Change Order will be issued to authorize the work. THIS IS NOT A CHANGE ORDER FOR AUTHORIZATION TO PROCEED WITH THE WORK AS DESCRIBED!

SCOPE OF WORK:

OWNER ________________________________
Form 01330-G

CHANGE ORDER PROPOSAL

Date ________________

Subject: Project Name _______________________________________

Project No. _______________________________________

Change Order No. _______________________________________

Dear Sir:

Certain items of extra work have been found necessary which are not covered by the Contract for the above referenced Project. Therefore, we submit the following amounts as the basis of compensation for such extra work:

JUSTIFICATION:

The Contract completion time will be (increased) (decreased) ____ consecutive calendar days.

Total Cost of Extra Work Covered by Above: $ __________

Previously Approved Extra Work: $ __________

Original Contract Amount $ __________

TOTAL: $ __________

By: ____________________________________________

Title: ____________________________________________

CONTRACTOR: ____________________________________
Form 01330-H
CHANGE ORDER DIRECTIVE

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

WORK CHANGE DIRECTIVE NUMBER X

CONTRACTOR: ___________________________ CONTRACT NUMBER: ________

IN ACCORDANCE WITH THIS CONTRACT, THE FOLLOWING CHANGE IS ORDERED.

DESCRIPTION:

☐ AUTHORIZATION FOR WORK DESCRIBED HEREIN TO PROCEED ON A NEGOTIATED COST BASIS.

☐ AUTHORIZATION FOR WORK DESCRIBED HEREIN TO PROCEED ON A TIME AND MATERIALS BASIS.

COST:

NET AMOUNT OF THIS WORK CHANGE DIRECTIVE = $________________

THE ENGINEER HAS REVIEWED THE COST FOR THIS WORK CHANGE DIRECTIVE AND CONSIDERS IT REASONABLE FOR THE LABOR AND MATERIAL NECESSARY TO COMPLETE THE WORK.

CONTRACT TIME: ☐ INCREASE BY _____ DAYS. ☐ NO CHANGE.

RECOMMENDED BY: ___________________________ DATE: ________

ENGINEER

ACCEPTED BY: ___________________________ DATE: ________

CONTRACTOR

APPROVED BY: ___________________________ DATE: ________

OWNER
## 01330-I CHANGE ORDER PRICING SHEET

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Quantity</th>
<th>Measure</th>
<th>C (x E)</th>
<th>G (x I)</th>
<th>K (x L)</th>
<th>M (x N)</th>
<th>O (F+H+J+L+N)</th>
<th>Subtotal</th>
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### TABLE 1 - Labor Rates

- **P. Work Classification**: Base Hourly, Total Hourly
- **Q. Base Hourly Wage Rate**: Submit Detail
- **R. Burden Rate**: 15.00%

### Notes:
- **11.6.2.1 Fee for work by Contractor**: 15.00%
- **11.6.2.5 Fee for net credit Change Order**: 5.00%
- **11.6.2.7 Fee for work by Subcontractor**: 5.00%

### Adjustments:
- **SUBTOTAL CHANGE ORDER AMOUNT**: $0.00
- **GRAND TOTAL CHANGE ORDER AMOUNT**: $0.00

---

**February 2018**

**01331-I**

**10093D11**
Form 01330-J
CHANGE ORDER

CITY OF PHOENIX
WATER SERVICES DEPARTMENT
CONSTRUCTION MANAGEMENT DIVISION

PROJECT NUMBER: WS90400079

In accordance with this contract, the following change is ordered, resulting in: (Check all that apply).

- Increase in Contract Amount
- No Change in Contract Amount
- Decrease in Contract Amount
- Increase in Contract Time
- No Change in Contract Time
- Decrease in Contract Time

DESCRIPTION: COST:

<table>
<thead>
<tr>
<th>AMOUNT: $__________</th>
<th>TIME (Days): _________</th>
<th>PRIOR CHANGE ORDER(S):</th>
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</thead>
<tbody>
<tr>
<td>AMOUNT: $__________</td>
<td>TIME (Days): _________</td>
<td>ORIGINAL CONTRACT:</td>
</tr>
<tr>
<td>AMOUNT: $__________</td>
<td>TIME (Days): _________</td>
<td>ADJUSTED CONTRACT:</td>
</tr>
</tbody>
</table>

Notice to Proceed Date: ____________________
Original Contract Completion Date: ____________
Adjusted Contract Completion Date: ____________

We, the undersigned, have given careful consideration to the change proposed, and hereby agree, if this proposal is approved, that we will provide all equipment, furnish all materials, except as may otherwise be noted above, and perform all services necessary for the work specified, and will therefore, accept as full payment, the fees or prices and adjustments in contract time shown above. This Change Order includes all direct costs such as labor, material, job overhead, profit, costs for modifications or changes in sequence of work to be performed, delays, rescheduling, disruptions, extended direct overhead or general overhead, acceleration, material or other escalation which include wages and other impact costs.

REVIEWED BY: ____________________ DATE: ____________
(Engineer)

RECOMMENDED BY: ____________________ DATE: ____________
(A or B - Project Manager) (C – Superintendent)

ACCEPTED (Contractor):

COMPANY/FIRM: ____________________
NAME OF CONTRACTOR ____________________

SIGNATURE: ____________________

TITLE: ____________________ DATE: ____________

PREPARED BY: ____________________

PROJECT MANAGER ____________________
# Request for Information

**Form 01330-K**

**REQUEST FOR INFORMATION**

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<tr>
<th>CONTRACTOR</th>
<th>RFI#</th>
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<tbody>
<tr>
<td>Requested By</td>
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<tr>
<td>Subject</td>
<td>Date Received</td>
</tr>
<tr>
<td>Spec. Section</td>
<td>Date Transmitted</td>
</tr>
<tr>
<td>Drawing References</td>
<td>Date Reply Received</td>
</tr>
<tr>
<td>Date Reply Needed</td>
<td>Date Reply Transmitted</td>
</tr>
</tbody>
</table>

### INFORMATION NEEDED:

Date ___________________________ Signature ___________________________

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### REPLY:

Date ___________________________ Signature ___________________________

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### Form 01330-L

#### REQUEST FOR ALTERATION

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<td>Drawing References</td>
<td>Date Reply Received</td>
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<tr>
<td>Date Reply Needed</td>
<td>Date Reply Transmitted</td>
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</table>

**REQUESTED ALTERATION:**

Date ___________________ Signature ___________________

**REPLY:**

Date ___________________ Signature ___________________
# CONTRACTOR'S DAILY CONSTRUCTION REPORT

**CONTRACTOR**

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<table>
<thead>
<tr>
<th>Project Name</th>
<th>Project No.</th>
<th>Report No.</th>
<th>Date</th>
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</thead>
</table>

## CONTRACTORS WORK FORCE:

<table>
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<tr>
<th>Force</th>
<th>Administrative</th>
<th>Supervisors</th>
<th>Carpenters</th>
<th>Iron Workers</th>
<th>Operators</th>
<th>Finishers</th>
<th>Welders</th>
<th>Electricians</th>
<th>Laborers</th>
</tr>
</thead>
</table>

## SUBCONTRACTORS WORK FORCE:

<table>
<thead>
<tr>
<th>Force</th>
<th>Mechanical</th>
<th>Electrical</th>
<th>Instrumentation</th>
<th>Site work</th>
<th>Masonry</th>
<th>Roofing</th>
<th>Rebar</th>
<th>Foundation</th>
<th>Painting</th>
</tr>
</thead>
</table>

## EQUIPMENT ON SITE:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>In Use</th>
<th>Not in Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loaders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dozers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrapers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compactors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trucks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backhoe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Work Performed:**

---

**Material and Equipment Delivered:**

---

**Remarks:**

---

By: ___________________________

Title: ___________________________

---

**February 2018 01330-M 10093D11**

pw:\Carollo\Documents\Client\AZ\Phoenix\10093D10\Specifications\01330-M (Additional Services FS)
Form 01330-N
TV INSPECTION REQUEST

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

DATE: ____________________  REQUESTOR: ________________
PHONE #: ____________________

LOCATION: ________________________________________________________________

REASON FOR INSPECTION: __________________________________________________

Q.S.: ____________________________

(PLEASE PROVIDE COPY OF SECTION TO BE INSPECTED)

LINEAL FT. TO INSPECT: ____________________

C/O-MH#: ____________________________ TO C/O-MH#: ____________________________

PIPE DIAM.: ____________________________

PIPE TYPE: ____________________________

DEPTH OF FLOW: __________________ IN.

MH DEPTH: ____________________________

DATE WHEN LAST CLEANED: MH=S: ________________ MAIN: ________________

COMMENTS: ________________________________________________________________

FOR TV SECTION ONLY

DATE RECEIVED: ____________________

ASSIGNED TO: ____________________ DATE: ________ EQUIP: __________

COMPLETED: ____________________ DATE: ________

COMMENTS: __________________________

______________________________
### CONTRACTOR SUBMITTAL REVIEW CHECKLIST

Contractor shall provide the completed review checklist with submittal to engineer. Submittals provided to the engineer without the completed checklist shall be rejected.

<table>
<thead>
<tr>
<th>Item</th>
<th>Review Description</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Submittal Meets Requirements per Specification 01330</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Submittal Meets Requirements of Referenced Specification Sections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>If Submittal is a Shop Drawing Check Form 01332-B is Attached</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>If Submittal is an O&amp;M Manual Check Form 01781 is Attached</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Contractor**

Certify either A or B:

___ A. We have verified that the material or equipment contained in this submittal meets all the specified requirements, including coordination with all related work. (no exceptions).

___ B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

<table>
<thead>
<tr>
<th>No.</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONTRACTOR’S SIGNATURE:** ___________________________ **DATE:** __________
Form 01330-P

SUBMITTAL REVIEW FORM

(Company Name)  
WS#  
Address:  
Contract #  

Phone:  
FAX:  

Submittal Review

<table>
<thead>
<tr>
<th>Project Title:</th>
<th>Submitting Firm:</th>
<th>Received Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility:</td>
<td>Reviewer:</td>
<td>Reviewed Date:</td>
</tr>
<tr>
<td>Submittal Title:</td>
<td>Reviewer Phone:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SPEC/DWG REFERENCE</th>
<th>COMMENT</th>
<th>RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional comments: *(your remarks here)*

Response Column:

- Inc. - Incorporated verbatim
- Inc. / Edit – Incorporated with modification – include explanation of modification
- N/I – Not Incorporated – include explanation
**FORM 01330-Q**  
**CONTRACTOR'S CONTINGENCY USAGE REQUEST**

---

**City of Phoenix**  
**Water Services Department**  
**Construction Management Division**

**CONTRACTOR CONTINGENCY USAGE REQUEST NUMBER XX**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>$0.00</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>$0.00</td>
</tr>
</tbody>
</table>

**ADJUSTMENTS:**

<table>
<thead>
<tr>
<th>This Contingency Amount</th>
<th>Prior Contingency Amount</th>
<th>Original Contingency Amount</th>
<th>Adjusted Contractors Contingency</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

**Total Deduction from Contractor Contingency**  
$0.00

**CONTRACT TIME:**  
X INCREASE BY 0 DAYS  
___ No Change

**RECOMMENDED BY:**

______________________________  
CONTRACTOR  
DATE: __________

**REVIEWED BY:**

______________________________  
ENGINEER  
DATE: __________

**AKNOWLEDGED BY:**

______________________________  
OWNER  
DATE: __________

---

February 2018  
01330-Q  
10093D11
# SUBMITTAL TRANSMITTAL

- **Project Name:**
- **Project No.:**
- **Contractor Name:**
- **Contract No.:**
- **Received By:**
- **Date:**
- **Provided By:**
- **Transmittal No.:**

**Submittal Type:**
- [ ] Pre-Construction
- [ ] Construction
- [ ] Substantial Completion
- [ ] Project Close Out

- **Submittal Description:**
- **Section No.:**
- **Submittal Review No.:**

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>No. Copies</th>
<th>Review Action</th>
<th>Review Comments Attached</th>
<th>Review Check List Attached</th>
<th>Reviewer Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Review Action:**
- **A** - Approved;  **AC** - Approved as Corrected;  **ACR** - Approved as corrected Resubmit
- **RR** - Revise and Resubmit;  **NR** - Not Reviewed;  **NA** - Not Approved
- **I** - For Information Only

---

**CONTRACTOR SIGNATURE/DATE**

**ENGINEER SIGNATURE/DATE**
Form 01332-B

SHOP DRAWING REVIEW CHECKLIST

<table>
<thead>
<tr>
<th>Item</th>
<th>Review Description</th>
<th>Contractor</th>
<th>Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equipment Parts List Provided with Manufacturer Model Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Equipment Manufacturer Catalog Datasheets Provided per piece of Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Suggested Spare Parts List Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Equipment Drawings Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Equipment and System Wiring Diagrams Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Applicable Certificates are Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Mounting Templates, Instructions and Design Calculations were Provided as Required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Required Maintenance Operations for Equipment 24 month Idle Period Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Unloading and Handling Methods Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Storage Requirements Provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Equipment Paint Submittal Provided and Meets Requirements of Division 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Drawings of Equipment Dimensions Field Verifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Materials that Contact Drinking Water Comply with Specifications for Drinking Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Submittal Includes requirements of Specification 01821 Instruction of Operations and Maintenance Personnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Equipment Specification Requirements have been meet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONTRACTOR’S SIGNATURE/DATE: ____________________________          ENGINEER’S SIGNATURE/DATE: ____________________________
Form 01415-A
Confined Space Data Sheet

Name of Confined Space: ______________________

Location of Confined Space: ______________________

Division/Section Responsible for Confined Space: ______________________

PRE-ENTRY SYSTEM CONTROL

Mechanical: Isolate, lockout and de-energize to zero potential energy. [ ]
Engulfment: Blank/block/cap/bleed off lines. Lock out gates, valves, pumps. [ ]
Electrical: Lockout/Tagout [ ]
Inerting: Flush/Purge/Vent [ ]
Special Precautions: ______________________

ATMOSPHERE

Date of least measured values: _____________

<table>
<thead>
<tr>
<th>Constituent</th>
<th>O₂</th>
<th>Explosive</th>
<th>H₂S/Toxic</th>
<th>CO</th>
<th>Date/Time Completed</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible</td>
<td>19.5%-23.5%</td>
<td>&lt;10% LFL</td>
<td>&lt;10ppm H₂S</td>
<td>&lt;35ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last Measured Values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SITE AND PERSONAL SAFETY (check if required, list type where applicable)

Personal Protective Equipment:
Safety Harness □ Life Lines □ Hard Hats □ Fall Protection □ Retrieval □ Eye □ Ear □
Face □ Hand □ Foot □ Respiratory □(type)___________ Clothing □(type)___________
Other: □

Rescue and Emergency Equipment:
Retrieval Equipment □ Fire Extinguishers □ Radios/Telephone □ Ladder □
Other □
Equipment on Standby for Rescue Personnel □

Site Safety:
Explosion-Proof Lighting □ Barriers/Shield/Barricades □(type)_____________________
Postings/Flagging □
Other □

List specific equipment isolated, de-energized, and locked out.
________________________________________
________________________________________
________________________________________
Form 01415-B
Confined Space Entry Permit

ENTRY TEAM
Division: __________________________ Facility: __________________________
Specific Confined Space Being Entered: __________________________
Purpose of Entry (Describe the Work): __________________________

Date: __________  Time: __________  Expected Job Duration (days/hours): ____
Entry Supervisor: __________________________  Designated Attendant: __________
Authorized/Qualified Entrants: __________________________

Entry-Team Rotation:
Date: __________  Time: __________
Entry Supervisor: __________________________  Designated Attendant: __________
Authorized/Qualified Entrants: __________________________

Entry-Team Rotation:
Date: __________  Time: __________  Expected Job Duration (days/hours): ____
Entry Supervisor: __________________________  Designated Attendant: __________
Authorized/Qualified Entrants: __________________________

Communication Procedures:
Entry Team: __________________________

Standby/Rescue Personnel: __________________________

Sign Offs:
Person Authorizing This Entry: __________________________
Entry Supervisor: __________________________
Person Terminating Permit: __________________________  Date: __________  Time: ____
Distribution To: __________________________
Form 01415-C
Confined Space Hot Work Permit

Division: ____________________________ Facility: ____________________________

Specific Confined Space Being Entered: ____________________________

Date: _______________ Time: _______________

Expected Job Duration (days/hours): ____________________________

Purpose of Entry (Describe the Work):
____________________________________________________________________
____________________________________________________________________

Explain Why Work Cannot Be Done Outside Of The Confined Space:
____________________________________________________________________
____________________________________________________________________

Safety Equipment Required:

Fire Extinguishers: Yes □ No □ Number: _____ Type:______________________

Respirators: Yes □ No □ Number: ________ Type:______________________

Other Equipment:__________________________________________________
____________________________________________________________________

Authorizing Supervisor:

Print Name: _______________________________________________________

Signature: _______________________________________________________

Date Signed: _____________________________________________________
EQUIPMENT INFORMATION FORM

INSTRUCTIONS

EACH PIECE OF EQUIPMENT PROVIDED WILL REQUIRE AN INDIVIDUAL EQUIPMENT INFORMATION FORM TO BE PROVIDED IN RESPECTIVE O&M MANUAL (I.E., PUMP AND MOTOR, FLOW METER AND TRANSMITTER, PUMP, MOTOR AND V.F.D., SLUICE GATES ETC.).

TITLE BLOCK (HEADER): INSERT PROJECT TITLE.

FACILITY LOCATION: LIST NAME OF WATER SERVICES DEPARTMENT FACILITY WHERE PROJECT IS LOCATED.

SERVICE DESC: PROVIDE DESCRIPTION AS STATED ON DRAWINGS, EXAMPLE: FOR THE DISCHARGE FLOWMETER ON PRIMARY SLUDGE PUMP #1, STATE: PRIMARY SLUDGE PUMP #1 DISCHARGE FLOW.

PROCESS LOCATION: WHERE IN THE PROCESS AT THIS FACILITY DOES ITEM RESIDE, (AS STATED ON THE DRAWINGS).

DRAWING REF: AS SHOWN ON THE ISSUED FOR CONSTRUCTION DRAWINGS. IF NOT AVAILABLE, LEAVE BLANK. (DO NOT STATE THE MANUFACTURERS DRAWINGS OR SCHEMATIC).

“CMMS TAG” # AND SERIALIZE KEY #: AS STATED ON DRAWINGS. IF NOT AVAILABLE, LEAVE BLANK.

VENDOR: PROVIDE NAME OF LOCAL EQUIPMENT REP/VENDOR, (I.E., HENNESY EQUIPMENT, JAMES, COOKE & HOBSON, SOUTHWEST CONTROLS, ETC.).

ASSOC. EQUIP’T: IF ITEM IS PART OF A LARGER PIECE OF EQUIPMENT, EXAMPLE: LUBE OIL PUMP ON BLOWER, THE BLOWER IS THE ASSOC. EQUIPMENT.

MANUF: MOYNO, FLYGT, MILLTRONICS, EATON, DEZURIK, TRANE, CARRIER, ETC.

TYPE: I.E., POSITIVE DISPLACEMENT, SUBMERSIBLE, CENTRIFUGAL, PORTABLE, SINGLE STAGE, TWO STAGE, ETC.

SIZE: VALVES AND GATES: LINE SIZE IN INCHES. AIR CONDITIONING SYSTEMS, OVERHEAD CRANES, AND BRIDGE CRANES: RATING IS IN TONS.
<table>
<thead>
<tr>
<th>Facility Location:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Desc:</td>
<td>Process Location:</td>
</tr>
<tr>
<td>Spec Section #:</td>
<td>Drawing Ref:</td>
</tr>
<tr>
<td>CMMS TAG #:</td>
<td>Serialized Key #:</td>
</tr>
<tr>
<td>Vendor:</td>
<td>Assoc. Equipment:</td>
</tr>
<tr>
<td>Manuf:</td>
<td>Type:</td>
</tr>
<tr>
<td>Model #:</td>
<td>Size:</td>
</tr>
<tr>
<td>Serial #:</td>
<td>GPM:</td>
</tr>
<tr>
<td>Temperature Range:</td>
<td>PSI Range:</td>
</tr>
<tr>
<td>CFM:</td>
<td>Operating Range:</td>
</tr>
</tbody>
</table>

**Electrical Equipment or Motor Data:**

- Manufacturer Name: 
- Horsepower: 
- Volts: 
- Amp’s: 
- Phase: AC or DC: 
- RPM’s: 
- Frame #: 
- Enclosure Nema Rating: 
- Service/Power Factor: 
- Insulation Class: 

**Miscellaneous Info:**

<table>
<thead>
<tr>
<th>Mechanical Data:</th>
</tr>
</thead>
</table>
| Belt Manufacturer: 
| Belt Model #: |
| Number of Belts: |
| Bearing Manufacturer: |
| Bearing Model #: |
| Weight Oil Used: |
| Amount Oil Required: |

**Miscellaneous Info:**

<table>
<thead>
<tr>
<th>Miscellaneous Info:</th>
</tr>
</thead>
</table>
Form 01600-B
CERTIFICATE OF UNIT RESPONSIBILITY

Lift Station 47 Civil & Electrical Improvements

CERTIFICATE OF UNIT RESPONSIBILITY
for Specification Section ________

(Section title)

In accordance with Paragraph 01600.1.2.B of the Contract Documents, the undersigned manufacturer accepts unit responsibility for all components of equipment furnished under specification Section _______. We hereby certify that these components are compatible and comprise a functional unit suitable for the specified performance and design requirements.

Notary Public

Name of Corporation

Commission expiration date

Address

Seal:

By: ____________________________

Duly Authorized Official

Legal Title of Official

Date: ___________________________

February 2018 01600-B 10093D11

pw://Carollo/Documents/Client/AZ/Phoenix/10093D10/Specifications/01600-B (Additional Services FS)
**EQUIPMENT MANUFACTURER/VENDOR/INSTALLER INFORMATION FORM**

**Project Title:**

**Equipment Type:**

<table>
<thead>
<tr>
<th>MANUFACTURER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: __________________________</td>
</tr>
<tr>
<td>Address: __________________________</td>
</tr>
<tr>
<td>City/State/Zip Code: __________________________</td>
</tr>
<tr>
<td>Office Phone: ____________________</td>
</tr>
<tr>
<td>Fax: ____________________</td>
</tr>
<tr>
<td>Web site: ____________________</td>
</tr>
<tr>
<td>E-mail address: ____________________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCAL REPRESENTATIVE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: __________________________</td>
</tr>
<tr>
<td>Address: __________________________</td>
</tr>
<tr>
<td>City, State, Zip: ____________________</td>
</tr>
<tr>
<td>Office Phone: ____________________</td>
</tr>
<tr>
<td>Fax: ____________________</td>
</tr>
<tr>
<td>Web site: ____________________</td>
</tr>
<tr>
<td>E-mail address: ____________________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSTALLER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: __________________________</td>
</tr>
<tr>
<td>Address: __________________________</td>
</tr>
<tr>
<td>City, State, Zip: ____________________</td>
</tr>
<tr>
<td>Office Phone: ____________________</td>
</tr>
<tr>
<td>Fax: ____________________</td>
</tr>
<tr>
<td>Web site: ____________________</td>
</tr>
<tr>
<td>E-mail address: ____________________</td>
</tr>
</tbody>
</table>
MANUFACTURER’S INSTALLATION CERTIFICATION FORM

Contract No.: ____________________  Specification Section: ________________

Equipment Name: _______________________________________________________

CONTRACTOR: _________________________________________________________

Manufacturer of Equipment Item: ____________________________________________

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the Contract Documents, has been provided in accordance with the manufacturer’s recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments:
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Date: ____________________  Manufacturer

__________________________________________________
Signature of Authorized Representative

Date: ____________________  CONTRACTOR

__________________________________________________
Signature of Authorized Representative
DELIVERY INSPECTION FORM

Project Name: ____________________________  Project No.: ____________________________
Contractor Name: ________________________  Contract No.: ____________________________
Equipment Description: ____________________  Equipment Tag No.: ______________________
Submittal No.: ______________________________  Specification Section No.: ____________
Materials and Equipment Supplier: ____________  Manufacturer: _________________________
Sender: ________________________________  Manufacturer: ____________________________
Receiving By: ____________________________  Date: _________________________________
P.O. No.: _______________________________  USPS Tracking No.: ________________________
Storage Facility Location: __________________

Delivery Checklist

<table>
<thead>
<tr>
<th>Item</th>
<th>Review Description</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equipment Delivered to Approved Storage Area per Specification 01661</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Equipment Shop Drawings have been Approved by Engineer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Required FAT Test have been Provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Equipment has been Provided in Original, Unopened, Legible Labeled Containers which are intact.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Quantities Provided are Correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Engineer has been Provided a Copy of the Delivery Inspection Form</td>
<td></td>
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</tr>
</tbody>
</table>

The CONTRACTOR has inspected the materials and equipment item(s) described above and hereby certifies that he has verified the satisfactory delivery of the materials and equipment and that the materials and equipment, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations, and that the status of the materials equipment item(s) has been satisfactory delivered and stored as requires in Section 01651 – Transportation and Handling of Materials and Equipment and Section 01661 – Storage of Materials and Equipment.

___________________________________________________                 ____________________________
CONTRACTOR'S SIGNATURE                                                                                            Date
NOTE: This example equipment test report is provided for the benefit of CONTRACTOR and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

CONTRACTOR

EQUIPMENT/SYSTEM TEST REPORT

Equipment Name: ____________________________
Equipment Number: ____________________________
Specification Reference: ____________________________
Location: ____________________________
System: ____________________________

<table>
<thead>
<tr>
<th>CONTRACTOR</th>
<th>ENGINEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verified Date</td>
<td>Verified Date</td>
</tr>
</tbody>
</table>

PRE-OPERATIONAL CHECKLIST

Mechanical

- Lubrication
- Alignment
- Anchor Bolts
- Seal Water System Operational
- Equipment Rotates Freely
- Safety Guards
- Valves Operational
- Hopper Purge Systems Operational
- Sedimentation Tank/Hopper Clean
- O&M Manual Information Complete
- Manufacturer’s Installation Certificate
### Electrical (Circuit and High-Pot Tests)

<table>
<thead>
<tr>
<th>Circuits</th>
<th>CONTRACTOR Verified</th>
<th>CONTRACTOR Date</th>
<th>ENGINEER Verified</th>
<th>ENGINEER Date</th>
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<tbody>
<tr>
<td>Power to MCC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control to HOA</td>
<td></td>
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<tr>
<td>Indicators:</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Red (Running)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Green (Stop)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Misc. Local Control Panel:</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Wiring Labels Complete</td>
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<tr>
<td>Nameplates</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Bumped for Rotation</td>
<td></td>
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### Piping Systems

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<thead>
<tr>
<th>Cleaned and Flushed:</th>
<th>CONTRACTOR Verified</th>
<th>CONTRACTOR Date</th>
<th>ENGINEER Verified</th>
<th>ENGINEER Date</th>
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</thead>
<tbody>
<tr>
<td>Suction</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Discharge</td>
<td></td>
<td></td>
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<tr>
<td>Pressure Tests</td>
<td></td>
<td></td>
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<tr>
<td>Temporary Piping Screens in Place</td>
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</table>

### Instrumentation and Controls

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<thead>
<tr>
<th>List Instruments: Instrument:</th>
<th>CONTRACTOR Verified</th>
<th>CONTRACTOR Date</th>
<th>ENGINEER Verified</th>
<th>ENGINEER Date</th>
</tr>
</thead>
</table>
EQUIPMENT/SYSTEM PERFORMANCE TESTS (Section 01752)

Mechanical

Motor Operating Temperature
Pump Operating Temperature
Unusual Noise, etc?

Pump operation: gpm/psig

Measurement:
Flow

Pressure

Test Gauge Number

Alignment Hot

Dowelled in

Remarks:

Electrical

Local switch function:

Runs in HAND

No Control Power in OFF

Timer control in AUTO

Overpressure protection switch

PS_____ functional in both

HAND and AUTO

PS_____ set at ___ psig

Equipment/System Performance Test Completed

Contractor Date

Equipment/System Performance Test Accepted

Engineer Date
**Commissioning Checklist**

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Field / SCADA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date &amp; Time</td>
<td>Day</td>
<td>Day</td>
</tr>
<tr>
<td>Location</td>
<td>Field / SCADA</td>
<td>of Commissioning Period</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment Checks</th>
<th>Checked</th>
<th>Comments / Issues</th>
</tr>
</thead>
</table>

**Pump**

- Check motor amperage
  - Pump # _____ AMPS
- Air relief valve leaking/unclean? [YES/ NO]
- Any leaking mechanical seals? [YES/ NO]
- Any abnormal vibration? [YES/ NO]
- Any abnormal noise? [YES/ NO]
- Liquid is flowing to the check valve cylinder? [YES/ NO]
- Elapsed time meter reading _____ HOURS
- Pump control valve position? [OPEN/ CLOSED]

**General Pump**

- SCADA suction pressure reading _____ PSI
- Suction pressure 50 - 55 psi? [YES/ NO]
- SCADA discharge pressure reading _____ PSI
- Discharge pressure 114 - 116 psi? [YES/ NO]
- Any alarms on? If so, discuss why [YES/ NO]
<table>
<thead>
<tr>
<th>Equipment Checks</th>
<th>Checked</th>
<th>Comments / Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Do SCADA readings match field readings?</td>
<td><strong>YES/ NO</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Air Compressor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Abnormal vibration?</td>
<td><strong>YES/ NO</strong></td>
<td></td>
</tr>
<tr>
<td>- Abnormal noise?</td>
<td><strong>YES/ NO</strong></td>
<td></td>
</tr>
<tr>
<td>- Check air intake filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Check the compressor and motor for lubrication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Check oil level in bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Check drive belt condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Elapsed time meter reading</td>
<td><strong>___ HOURS</strong></td>
<td></td>
</tr>
<tr>
<td>- Excessive run time</td>
<td><strong>YES/ NO</strong></td>
<td></td>
</tr>
<tr>
<td>- Record air pressure</td>
<td><strong>___ PSI</strong></td>
<td></td>
</tr>
<tr>
<td>- Any alarms on? If so, discuss why</td>
<td><strong>YES/ NO</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Commissioning Checklist**

<table>
<thead>
<tr>
<th>Equipment Checks</th>
<th>Checked</th>
<th>Comments / Issues</th>
</tr>
</thead>
</table>

**Suction Surge Tank**

- Look for water leaks
- Listen for air leaks
- Check air relief valve for leaks & cleanliness
- Record water level in sight gauge _____ IN (inches above or below center of tank)
- Is level between high level open and low level close solenoid valve probes? **YES/ NO**
- Record suction pressure _____ PSI
- Is suction pressure within expected pressure range 50 - 55 psi? **YES/ NO**
- Any alarms on? If so, discuss why **YES/ NO**
- SCADA pressure reading _____ IN
- Do SCADA level/alarms match field readings? **YES/ NO**
Test Plan

Project: Equipment/System Name: RTU
Contractor: Reference Drawing: (Process and Instrumentation Drawing)

Test Group: A - HSQ Remote Terminal Unit (RTU) Panel including CCS Communication System

<table>
<thead>
<tr>
<th>Description</th>
<th>Contractor</th>
<th>Witness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Tasks</td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>Completed test objective Sign off:</td>
<td>Verified</td>
<td>Date</td>
</tr>
</tbody>
</table>

A Pre-Test
B Electric Power Supply and Associated Alarms
C Panel Lighting
D Uninterruptable Power Supply (UPS)
E Digital and Analog Inputs and Outputs

**All associated tasks must be completed to verify the test objective was completed

Test Plan:

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre-Test</td>
<td>**</td>
</tr>
<tr>
<td>B</td>
<td>Electric Power Supply and Associated Alarms</td>
<td>**</td>
</tr>
<tr>
<td>C</td>
<td>Panel Lighting</td>
<td>**</td>
</tr>
<tr>
<td>D</td>
<td>Uninterruptable Power Supply (UPS)</td>
<td>**</td>
</tr>
<tr>
<td>E</td>
<td>Digital and Analog Inputs and Outputs</td>
<td>**</td>
</tr>
</tbody>
</table>

**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.
Contractor's Functional Test Plan

**Test Group: B - Disinfection System PLC Panel PNL #______**

<table>
<thead>
<tr>
<th>Completed test objective</th>
<th>Sign off:</th>
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</thead>
<tbody>
<tr>
<td><strong>A</strong> Pre-Test</td>
<td></td>
</tr>
<tr>
<td><strong>B</strong> Electric Power Supply and Associated Alarms</td>
<td></td>
</tr>
<tr>
<td><strong>C</strong> Panel Lighting</td>
<td></td>
</tr>
<tr>
<td><strong>D</strong> Uninterruptable Power Supply (UPS)</td>
<td></td>
</tr>
<tr>
<td><strong>E</strong> Air Conditioner</td>
<td></td>
</tr>
<tr>
<td><strong>F</strong> Programmable Logic Controller (PLC)</td>
<td></td>
</tr>
</tbody>
</table>

**Please refer to Reference Drawing:** [Process and Instrumentation Drawing]

**Contractor:**

**Test Plan:**

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Pre-Test</td>
<td></td>
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<tr>
<td>B</td>
<td>Electric Power Supply and Associated Alarms</td>
<td></td>
</tr>
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<td>Panel Lighting</td>
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</tr>
<tr>
<td>D</td>
<td>Uninterruptable Power Supply (UPS)</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Air Conditioner</td>
<td></td>
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<tr>
<td>F</td>
<td>Programmable Logic Controller (PLC)</td>
<td></td>
</tr>
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</table>

**Contractor's Functional Test Plan**

<table>
<thead>
<tr>
<th><strong>Task</strong></th>
<th><strong>Description</strong></th>
<th><strong>Contractor</strong></th>
<th><strong>Witness</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Pre-Test</td>
<td></td>
<td>Verified Date</td>
<td>Verified Date</td>
</tr>
<tr>
<td><strong>B</strong> Electric Power Supply and Associated Alarms</td>
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<tr>
<td><strong>C</strong> Panel Lighting</td>
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</tr>
<tr>
<td><strong>D</strong> Uninterruptable Power Supply (UPS)</td>
<td></td>
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</tr>
<tr>
<td><strong>E</strong> Air Conditioner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F</strong> Programmable Logic Controller (PLC)</td>
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</tr>
</tbody>
</table>

**All associated tasks must be completed to verify the test objective was completed.**

**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

Project: Lighting System
Reference Drawing: Process and Instrumentation Drawing

Test Group: C - Lighting System

<table>
<thead>
<tr>
<th>Associated Tasks</th>
<th>Description</th>
<th>Contractor</th>
<th>Witness</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre-Test</td>
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<td>Date</td>
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<tr>
<td>B</td>
<td>Site Lighting</td>
<td>Verified</td>
<td>Date</td>
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</tr>
<tr>
<td>C</td>
<td>Electrical Equipment Area Lighting</td>
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<td>Date</td>
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</tr>
<tr>
<td>D</td>
<td>Disinfection Building Lighting</td>
<td>Verified</td>
<td>Date</td>
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</tr>
<tr>
<td>E</td>
<td>Site Electrical Receptacles</td>
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<td>Date</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Electrical Equipment Area Electrical Receptacles</td>
<td>Verified</td>
<td>Date</td>
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<tr>
<td>G</td>
<td>Disinfection Building Electrical Receptacles</td>
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<td>Date</td>
<td></td>
</tr>
</tbody>
</table>

**All associated tasks must be completed to verify the test objective was completed.**

Test Plan:

<table>
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<tr>
<th>Task #</th>
<th>Task Description</th>
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<tbody>
<tr>
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<tr>
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<td>B</td>
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<td></td>
<td>1 **</td>
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<td>C</td>
<td>Electrical Equipment Area Lighting</td>
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<td></td>
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<td>D</td>
<td>Disinfection Building Lighting</td>
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<td>1 **</td>
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</table>

**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
### Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Hydropneumatic Tank

**Reference Drawing:** (Process and Instrumentation Drawing)

#### Test Group: D - Suction Hydropneumatic Tank # and Air Compressor #_____

<table>
<thead>
<tr>
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<th>Associated Tasks</th>
<th>Description</th>
<th>Contractor</th>
<th>Witness</th>
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<tbody>
<tr>
<td>A Pre-Test Checks</td>
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<tr>
<td>B HAND OPERATION</td>
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<td>Date</td>
</tr>
<tr>
<td>C High Air Pressure</td>
<td></td>
<td></td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>D Motor Overload</td>
<td></td>
<td></td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>E Low Lube Oil Level</td>
<td></td>
<td></td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>F Suction Hydropneumatic Tank Water Level High High (LSHH #_____)</td>
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<tr>
<td>G Suction Hydropneumatic Tank Water Level Low Low (LSLL #_____)</td>
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<tr>
<td>H Low Booster Station Suction Pressure (PSL #___<em>)</em>- Local Reset</td>
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</tr>
<tr>
<td>I Low Booster Station Suction Pressure (PSL #___<em>)</em>- CCS Reset</td>
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<tr>
<td>J AUTOMATIC OPERATION</td>
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<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>K High Air Pressure</td>
<td></td>
<td></td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>L Motor Overload</td>
<td></td>
<td></td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>M Low Lube Oil Level</td>
<td></td>
<td></td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>N Suction Hydropneumatic Tank Water Level High High (LSHH #_____)</td>
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<td></td>
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<tr>
<td>O Suction Hydropneumatic Tank Water Level Low Low (LSLL #_____)</td>
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<tr>
<td>P Low Booster Station Suction Pressure (PSL #___<em>)</em>- Local Reset</td>
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</tr>
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<td>Q Low Booster Station Suction Pressure (PSL #___<em>)</em>- CCS Reset</td>
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</table>

**All associated tasks must be completed to verify the test objective was completed.**
Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Test Plan</th>
<th>Task #</th>
<th>Task Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>Pre-Test Checks</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>HAND OPERATION</td>
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<tr>
<td>C</td>
<td></td>
<td>High Air Pressure</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>Motor Overload</td>
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<tr>
<td>E</td>
<td></td>
<td>Low Lube Oil Level</td>
<td></td>
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<tr>
<td>F</td>
<td></td>
<td>Suction Hydropneumatic Tank Water Level High High (LSHH #_____)</td>
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<tr>
<td>G</td>
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<td>Suction Hydropneumatic Tank Water Level High Low (LSLL #_____)</td>
<td></td>
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<tr>
<td>H</td>
<td></td>
<td>Low Booster Station Suction Pressure (PSL #_____)- Local Reset</td>
<td></td>
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<tr>
<td>I</td>
<td></td>
<td>Low Booster Station Suction Pressure (PSL #_____)- CCS Reset</td>
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</tr>
<tr>
<td>J</td>
<td></td>
<td>AUTOMATIC OPERATION</td>
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<td>K</td>
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<td>High Air Pressure</td>
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<td>M</td>
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<tr>
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<td>Suction Hydropneumatic Tank Water Level Low Low (LSLL #_____)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>Low Booster Station Suction Pressure (PSL #_____)- Local Reset</td>
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</tr>
<tr>
<td>Q</td>
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<td>Low Booster Station Suction Pressure (PSL #_____)- CCS Reset</td>
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</tr>
</tbody>
</table>

**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Project:</th>
<th>Equipment/System Name: Hydropneumatic Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Reference Drawing: Process and Instrumentation Drawing</td>
</tr>
</tbody>
</table>

Test Group: E - Discharge Hydropneumatic Tank # and Air Compressor 

<table>
<thead>
<tr>
<th>Associated Tasks</th>
<th>Description</th>
<th>Verified</th>
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**All associated tasks must be completed to verify the test objective was completed**
### Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Hydropneumatic Tank

**Contractor:**

**Reference Drawing:** [Process and Instrumentation Drawing]

**Test Group:** E - Discharge Hydropneumatic Tank # and Air Compressor 

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## Contractor's Functional Test Plan

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
## Contractor's Functional Test Plan

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**All associated tasks must be completed to verify the test objective was completed.**
### Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Pump #

**Contractor:**

**Reference Drawing:** (Process and Instrumentation Drawing)

**Test Group:** F - Booster Pump #_____

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**Contractor's Functional Test Plan**

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

Test Group: G - Booster Pumps in Multiple Operation

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| C | REMOTE (HSQ/RTU CCS CONTROL) OPERATION | | | | | **All associated tasks must be completed to verify the test objective was completed**

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

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Test Group: H - Booster Pumps' Discharge Header Pressure Relief

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

Project: LIFT STATION 47 CIVIL ELECTRICAL IMPROVEMENTS
Contractor: ___________________________
Equipment/System Name: Flush System
Reference Drawing: (Process and Instrumentation Drawing)

Test Group: I - Booster Pumps' Suction Header Flushing System

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
**Contractor's Functional Test Plan**

**Project:**

**Equipment/System Name:** Chlorine Residual Sampling

**Contractor:**

**Reference Drawing:** (Process and Instrumentation Drawing)

**Test Group:** J - Chlorine Residual Sampling System #_____ (Booster Station Suction Side)

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**All associated tasks must be completed to verify the test objective was completed.**

**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
## Contractor's Functional Test Plan

**Equipment/System Name:** Chlorine Residual Sampling  
**Reference Drawing:** (Process and Instrumentation Drawing)

### Test Group: K - Chlorine Residual Sampling System #_____ (Booster Station Discharge Side)

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

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Test Group: L - Booster Station Discharge Flow Meter and Totalizer

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
## Contractor's Functional Test Plan

**Project:** [Project Information]

**Equipment/System Name:** Potable Water and Waste System

**Reference Drawing:** (Process and Instrumentation Drawing)

### Test Group: M - Disinfection Building Potable Water and Waste Systems

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Contractor's Functional Test Plan

**Project: Equipment/System Name:** Ventilation System  
**Contractor:**  
**Reference Drawing:** (Process and Instrumentation Drawing)

Test Group: N - Disinfection Building Ventilation System

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Contractor's Functional Test Plan

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**Test Group: 0 - Disinfection Building Heating System**

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**Contractor's Functional Test Plan**

**Project:**

**Equipment/System Name:** Fire and Smoke Detection System

**Reference Drawing:** Process and Instrumentation Drawing

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### Contractor's Functional Test Plan

**Project:** ________________________________  **Equipment/System Name:** Containment System  
**Contractor:** ________________________________  **Reference Drawing:** (Process and Instrumentation Drawing)

#### Test Group: Q - Disinfection Building Secondary Containment System

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## Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Chlorine System

**Reference Drawing:** (Process and Instrumentation Drawing)

### Test Group: R - Tablet Chlorination System

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<td>D <strong>MANUAL OPERATION</strong></td>
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Contractor's Functional Test Plan

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Test Group: S - Disinfection System PLC (PNL #______)

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**Contractor's Functional Test Plan**

**Project:**

**Equipment/System Name:** Disinfection System

**Contractor:**

**Reference Drawing:** (Process and Instrumentation Drawing)

**Test Group: S - Disinfection System PLC (PNL #______)**

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**Test Group: T - Standby Generator and Automatic Transfer Switch**

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

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Contractor's Functional Test Plan

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Test Group: U - Intrusion System

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## Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Security System

**Contractor:**

**Reference Drawing:** [Process and Instrumentation Drawing](#)

### Test Group: V - Security System Startup and Testing

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**Contractor's Functional Test Plan**

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**Contractor's Functional Test Plan**

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**Test Group: W - Electric Gate Operator System**

### Completed test objective Sign off:

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Note: All associated tasks must be completed to verify the test objective was completed.

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### Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Non-Potable System

**Reference Drawing:** (Process and Instrumentation Drawing)

### Test Group: X - Non-Potable Water System

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<td><strong>C</strong></td>
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Contractor's Functional Test Plan

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**Contractor's Functional Test Plan**

**Project:**

**Equipment/System Name:** Wall Fans

**Reference Drawing:** (Process and Instrumentation Drawing)

Test Group: Z - Propeller Wall Fans

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Unit Heaters

**Reference Drawing:** (Process and Instrumentation Drawing)

### Test Group: AA - Unit Heaters

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## Contractor's Functional Test Plan

**Project:** LIFT STATION 47 CIVIL ELECTRICAL IMPROVEMENTS  
**Project Number:** WS90400079  
**Contractor:** 

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### Test Group: AB - Pressure Regulated Station

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Note: All associated tasks must be completed to verify the test objective was completed.
**Contractor's Functional Test Plan**

**Project:**

**Equipment/System Name:** Pressure Regulated Station

**Contractor:**

**Reference Drawing:** (Process and Instrumentation Drawing)

---

### Test Group: AB - Pressure Regulated Station

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

**Project:**

**Equipment/System Name:** Pump Control Valves

**Reference Drawing:** (Process and Instrumentation Drawing)

---

Test Group: AC - Pump Control Valves

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<td>B  Pump Control Valve Solenoid</td>
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<td>C  Pump Control Valve Close Switch</td>
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<td>D  Pump Control Valve Open Switch</td>
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Note: All associated tasks must be completed to verify the test objective was completed.

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Test Plan:

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
## Contractor's Functional Test Plan

### Project: Equipment/System Name:
- **Project:** LIFT STATION 47 CIVIL ELECTRICAL IMPROVEMENTS
- **System Name:** Pressure Reducing Valves

### Reference Drawing:
- Process and Instrumentation Drawing

### Test Group: AD - Pressure Reducing Valves

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Note: All associated tasks must be completed to verify the test objective was completed.

### Test Plan:

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Contractor's Functional Test Plan

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**All associated tasks must be completed to verify the test objective was completed.**

Test Plan:

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**

Test Group: AE - Electric Power Service Entrance Section SES #_____ and Customer Power Metering Systems
Contractor's Functional Test Plan

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<th>Equipment/System Name: SES</th>
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Test Group: AF - Electric Power Service Entrance Section SES #____

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**All associated tasks must be completed to verify the test objective was completed.**

Test Plan:

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**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
**Contractor's Functional Test Plan**

**Project:**

**Equipment/System Name:** Electric Power Distribution System

**Contractor:**

**Reference Drawing:** (Process and Instrumentation Drawing)

---

### Completed test objective Sign off:

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**Test Group: AF - Electric Power Distribution System**

**Task Description**

- **Pre-Test Checks**
- **Operational**

**Test Plan:**

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**Comments:**

- **All associated tasks must be completed to verify the test objective was completed.**
- **The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
Emergency Contact Information:

In the event of a serious injury emergency call 911 first.

All other emergencies or concerns call the listed personnel below in order until a representative is reached.

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Contact Information:

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Equipment and Instrumentation Checkout Log

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CITY OF PHOENIX: Water Services Department
PROJECT NAME: LIFT STATION 47 CIVIL ELECTRICAL IMPROVEMENTS
PROJECT NUMBER: WS90400079

Instrumentation Calibration Log

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Startup Team:

**Role:** Quality Control Manager

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Contact Information:

**Role:** General Contractor

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Contact Information:

**Role:** Owner

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Contact Information:

**Role:** Owner Representative

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Contact Information:
Test Setup Form

Project: ________________ Location: ______

Test System Group: ______________________________________

Detailed Test Configuration, temporary connections, and bypass: ______

Est. Duration (hr): __________ Est. Flow / Usage (Mgd): ______

System Limitation: Details and why a scenario or equipment can not be tested due to process demands or unattainable configurations.

Required Personnel to Complete Testing:

General Contractor: __________________ Construction Manager: __________________
Electrical Contractor: __________________ Inspector: __________________
Programmer: __________________ Safety Personnel: __________________
Owner's Staff: __________________ Mechanical Contractor: __________________
Engineer: __________________ Quality Control Manager: __________________

Prepared By: Name and Company

**See the Test System Groups for a list of items being tested**
Test System Group

Project: ___________________  Reference Drawing: ___________________

Test Group:

Equipment: 

Instrumentation: 

Mechanical: 

**Form 01781-A**

**OPERATIONS & MAINTENANCE MANUAL REVIEW CHECKLIST**

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<th>Review Description</th>
<th>Contractor</th>
<th>Engineer</th>
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<td>Final copies required hard/soft</td>
<td>Yes/No/N/A</td>
<td>Yes/No/N/A</td>
</tr>
<tr>
<td>2</td>
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ENGINEER’S SIGNATURE/DATE: ________________________________
**OPERATIONS & MAINTENANCE DATA REVIEW CHECKLIST**

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**Comments:**

1.  

---

**Engineer**

**Date**

February 2018  
01781-B  
10093D11
**Form 01783-A**

**SPARE PARTS RECEIVER FORM**

**CONTRACTOR TO FILL OUT:**

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**PART TO BE USED ON**

**WHAT EQUIPMENT:**

**EQUIPMENT NUMBER:** ________________ **SPECIFICATION SECTION:**

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Form 01785-A

PREVENTIVE MAINTENANCE DATA SUBMITTAL FORM

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Project Name: Lift Station 44 Civil Improvements  
City Project #: WS90400076

Engineer:  
Contractor:  

Asset Type Description:  
Asset Manufacturer:
MANUFACTURER’S INSTRUCTION CERTIFICATION FORM

Contract No: ______ Specification Section: ______ Equipment Name: ______

CONTRACTOR: ____________________________

Manufacturer of equipment item: ____________________________

The undersigned manufacturer certifies that a service engineer has instructed the Plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)

- Start-up procedure reviewed. ______
- Shutdown procedure reviewed. ______
- Normal operation procedure reviewed. ______
- Others: ____________________________ ______

Maintenance Check List (check appropriate spaces)

- Described normal oil changes (frequency). ______
- Described special tools required. ______
- Described normal items to be reviewed for wear. ______
- Described preventive maintenance instructions. ______
- Described greasing frequency. ______
- Others: ____________________________ ______

Date Manufacturer

Signature of Authorized Representative

Date Signature of OWNER’S Representative

Date Signature of CONTRACTOR’S Representative
Form 01821-B

Training Request Form

Specification Section 01821
Instruction of Operations and Maintenance Personnel

Equipment Name: __________________________________________

Equipment Tag Number: ______________________________________

Equipment Description: ______________________________________

Specification Section: _______________________________________

Operations and Maintenance Data Submitted/Approved: __________

Start-up and Testing Complete/Date: ______________________________

Lesson Plan Submitted/Approved: _______________________________

Training Aids Submitted/Approved: _______________________________

Hands-on Demonstration: _______________________________________

Training Schedule (Dates, Time, No. of Sessions): ___________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________
Form 11000-A

MOTOR DATA FORM:

Equipment Name
Equipment No.(s)
Site Location

Nameplate Markings

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The following information is required for explosion proof motors only:

A. Approved by UL for installation in Class _____, Div ______
B. UL Frame Temp. Code  Group _______ Atmosphere  
   (NEC Tables 500-2 and 500-2(b))

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed Minimum Efficiency  (Section 11000)
B. Nameplate or Nominal Efficiency

Data Not Necessarily Marked on Nameplate

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Space heater included? ______ Yes ______ No; if Yes, _____ watts _____ volts

Type of motor winding over-temperature protection, if specified:

Use the space below to provide additional information on other motor modifications, if specified:
### FEEDER SCHEDULE

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February 2018  16215-A-2  10093D11
### SES MCB

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| Manufacturer |  |
| Type |  |
| Series/Style |  |
| ID No. |  |
| Model No. |  |
| Serial/Style No. |  |
| Catalog No. |  |
| Frame Amps |  |

| Continuous Amp Rating |  |
| Voltage |  |
| Phase |  |
| Current Rating Interrupt |  |
| RMS SYM. AMPS |  |
| Temp. |  |
| Trip Unit |  |
| Unique Plug |  |
| Max Plug Rating |  |
| Max Rating Plug Catalog No. |  |
| Plug Rating |  |
| Actual Rating Plug Catalog No. |  |
| Push to Test |  |
| Number of Adjustments |  |
| Range of Adj. Settings |  |
| Increment |  |

<p>| Description |  |
| Label | Protection Type | Manufacturer | Type | Series/Style | ID No. | Model No. | Serial/Style No. | Catalog No. | Switch Rating | Switch Poles | Fuse Rating | Fuse Type | Load | Description |
|-------|-----------------|--------------|------|--------------|--------|-----------|-----------------|-------------|---------------|-------------|-------------|-----------|--------|------|-------------|
| SES CUBICLES | | | | | | | | | | | | | | | |
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February 2018  16215-A-7  10093D11
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<th>Style</th>
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<th>Serial No.</th>
<th>Model No.</th>
<th>Catalog No.</th>
<th>Vertical Amps</th>
<th>Horizontal Amps</th>
<th>Voltage</th>
<th>AIC</th>
<th>Frequency</th>
<th>Phase</th>
<th>Wire</th>
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<th>Type</th>
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<th>Serial No.</th>
<th>Style</th>
<th>Amperage</th>
<th>Phase</th>
<th>Voltage</th>
<th>AIC</th>
<th>Unique Plug</th>
<th>Unique Plug Rating</th>
<th>Push to Test</th>
<th>Number of Adjustments</th>
<th>Range of Adj. Settings</th>
<th>Increment</th>
<th>Adjustment 1</th>
<th>Adjustment 2</th>
<th>Adjustment 3</th>
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Notes:
CITY OF PHOENIX: Water Services Department
PROJECT NAME: LIFT STATION 47 CIVIL ELECTRICAL IMPROVEMENTS
PROJECT NUMBER: WS90400079

<table>
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Notes:
### MOTORS

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<tr>
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<tbody>
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<td>Date:</td>
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<tbody>
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<tr>
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<tr>
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<td>Phase</td>
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</tr>
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<td>Voltage</td>
<td></td>
</tr>
<tr>
<td>Frame</td>
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<td>Enclosure Type</td>
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<td></td>
</tr>
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<td>Insul. Class</td>
<td></td>
</tr>
<tr>
<td>Duty</td>
<td></td>
</tr>
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<td>Weight</td>
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<td>Poles</td>
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**Notes:**
Form 16215-B

POWER COORDINATION - ARC FLASH LABELING SIGN-OFF FORM

<table>
<thead>
<tr>
<th>COMPANY NAME</th>
<th>DATE:</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Study Firm</th>
<th>Logo</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Project Title:</th>
<th>Study Firm Representative:</th>
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<tbody>
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<th>Plant/Site:</th>
<th>City of Phoenix Project #: WS</th>
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<tr>
<th>Contract Drawing #:</th>
<th>Contract Reference Spec. #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

Per Specification 16215 – Power Study, the Power Coordination - Arc Flash Analysis Report breaker settings, arc flash / voltage labels, single line diagrams and panel schedules are incorporated on the equipment to the satisfaction of the CONTRACTOR, ENGINEER and OWNER.

The attached table identifies the breaker settings on the equipment at the time the labels were installed.

_____________________________ Date _____________
CONTRACTOR’S Representative (Print Name & Sign)

_____________________________ Date _____________
ENGINEER’S Representative (Print Name & Sign)

_____________________________ Date _____________
OWNER’S Representative (Print Name & Sign)
<table>
<thead>
<tr>
<th>Referenced TCC</th>
<th>Breaker</th>
<th>Breaker Type</th>
<th>Trip Unit</th>
<th>Sensor/Plug</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R/S LTPU LTD STPU STD INST GNDPU GNDD</td>
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<td>REC</td>
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<td>REC</td>
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<td>REC</td>
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</table>
Form 17001-A

INSTRUMENT TUBING LEAK TEST FORM

Loop No.: ____________________________

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

<table>
<thead>
<tr>
<th>Tube No.</th>
<th>Tubing Length (feet)</th>
<th>Initial Pressure (psi)</th>
<th>Measured Pressure Drop (psi)</th>
<th>Measured Pressure Drop (psi)</th>
<th>Permitted Pressure Drop (psi)</th>
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</tbody>
</table>

CERTIFIED ___________________________ Date ___________________________.
CONTRACTOR’S Representative

WITNESSED ___________________________ Date ___________________________.
OWNER’S Representative
Form 17001-B

CALIBRATION TEST DATA FORM

Tag No. and Description: _____________________________

Make and Model No.: ____________________ Serial No.: ____________

Input: ________________________________ Output: ________________

Scale: ________________________________ Range: ________________

<table>
<thead>
<tr>
<th>% of Range/ Set Point</th>
<th>Display Reading</th>
<th>Output Reading</th>
<th>% Deviation</th>
<th>Calibration Basis</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td>☐ Increasing ☐ Decreasing</td>
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<tr>
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Instrument Programming Parameters

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<tr>
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<td>4.</td>
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CERTIFIED ____________________________ Date____________________

CONTRACTOR’S Representative

WITNESSED ____________________________ Date____________________

OWNER’S Representative
Form 17001-C

FUNCTIONAL ACCEPTANCE TEST

<table>
<thead>
<tr>
<th>System:</th>
<th>P&amp;ID No.:</th>
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<tbody>
<tr>
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Factory Acceptance Test:

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<th>Loop No.:</th>
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<tr>
<th>Loop Description:</th>
<th>Instrument Location:</th>
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<table>
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<tr>
<th>Manufacturer:</th>
<th>Model Number/Serial Number:</th>
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<table>
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<tr>
<th>Adjustable Range:</th>
<th>Calibrated Range:</th>
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</thead>
</table>

Remarks:

Installation Per Manufacturer’s Requirements? Yes: No:

Installation Per Contract Documents? Yes: No:

If “No,” Explain:

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<tr>
<th>Calibration Test:</th>
<th>Switch Test:</th>
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<tr>
<td>% Signal Calibration</td>
<td>Instrument Indication Error</td>
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<td>0</td>
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SECTION 01332

SHOP DRAWING PROCEDURES

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 01785, Preventive Maintenance Data and Section 01821, 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. Field verify all dimensions and existing materials shown on the Drawings. Any modifications required shall be at CONTRACTOR'S expense.
13. For materials or products which can contact drinking water as part of a Water Treatment Process or Water Supply System Certificate of Compliance with
C. Preliminary Submittal Schedule: CONTRACTOR, within 14 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 30 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, 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. Identify submittal(s) for which long review periods are anticipated.

F. Hereby notified that the project electric motor requirements, specified in Section 11000, Electric Motors, do not allow standard "off the shelf" motors. 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. Also, identify submittal for which he anticipates long review periods.

H. CONTRACTOR'S Submittal Schedule shall be consistent with the Progress Schedule as described in Section 01320, Progress Schedule.

I. Approval of the Submittal Schedule shall be required prior to processing of the first progress payment.

J. Submit Shop Drawings for early deliverables items at the Pre-construction Conference. These include, but are not limited to the following:
   1. To be determined by the Contractor.

1.2 PROCEDURE

A. Submit Shop Drawings to: Carollo Engineers, 4600 East Washington Street, Suite 500 Phoenix, AZ 85034.

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.

(The remainder of this page was left blank intentionally.)
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 15101, Ductile Iron Pipe, would be 15101-003.

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 15101, Ductile Iron Pipe is:

<table>
<thead>
<tr>
<th>Submittal Number</th>
<th>Review Cycle</th>
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</thead>
<tbody>
<tr>
<td>15101-003</td>
<td>001</td>
</tr>
</tbody>
</table>

An example of the typical submittal identification numbers for the second submission of the third submittal submitted under Section 15101, Ductile Iron Pipe is:

<table>
<thead>
<tr>
<th>Submittal Number</th>
<th>Review Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>15101-003</td>
<td>002</td>
</tr>
</tbody>
</table>

I. Initially submit to ENGINEER a minimum of three HARD copies and one 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.
   7. For Information Only.

K. If a submittal is acceptable, the ENGINEER will mark it "Approved" or "Approved as Corrected" and will forward one hard copies and one 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 one prints or copies 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, one copies 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 01330.1.2.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 01412

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 02315, 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 02315, 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.
SECTION 01413

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:
   2. Title 40 Code of Federal Regulations, Environmental Protections.
   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.

(The remainder of this page was left blank intentionally.)
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 14 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 30 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 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 01415

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, 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.
   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 01331, 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 01416

SPECIAL INSPECTIONS

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 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. Exceptions:
      1) The special inspector need not be present during the entire installation and tightening operation, provided he has:
         a) Inspected the surfaces and bolt type for conformance to plans and specifications prior to start of bolting, and "will, upon completion of all bolting, verify the minimum specified bolt tension for ten percent of the bolts for each connection, with a minimum of two bolts per connection".
      2) 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.
3. Reinforcing Steel.
4. Structural Welding.
5. Structural masonry.
7. Electrical Inspections.

1.2 SPECIAL INSPECTOR

A. The special inspector shall be a 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 the Work assigned to be certain it conforms to the Contract Documents.
B. The special inspector shall furnish 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 report stating whether the Work requiring special inspection was, to the best of his 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 01420

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 01630, Equipment Identification Tag System 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)  20°C
- degree Fahrenheit  68°F
- Diameter  dia.
- direct current  DC
- Dollars  $
- Each  ea
- Efficiency  eff
- Fahrenheit  F
- feet per hour  fph
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</table>
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).
5. American Iron and Steel Institute (AISI).
7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
8. American Society of Mechanical Engineers (ASME).
10. American Water Works Association (AWWA).
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).
18. Occupational Safety and Health Administration (OSHA).
20. Prestressed Concrete Institute (PCI).
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.
27. Uniform Building Code as supplemented by the City of Phoenix, Building Construction 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. 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.

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<th>Term</th>
<th>Definition</th>
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<td>Phoenix Building Code</td>
<td>International Building Code with City of Phoenix Amendments</td>
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<tr>
<td>Phoenix Electrical Code</td>
<td>National Electric Code – NFPA 70 with City of Phoenix Amendments</td>
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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:

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 ASTM International
26. ASCE American Society of Civil Engineers
<table>
<thead>
<tr>
<th></th>
<th>Abbreviation</th>
<th>Full Name</th>
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<tbody>
<tr>
<td>27.</td>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating and Air Conditioning</td>
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<td>28.</td>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>29.</td>
<td>AWI</td>
<td>Architectural Woodwork Institute</td>
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<td>30.</td>
<td>AWPA</td>
<td>American Wood Preservers' Association</td>
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<tr>
<td>31.</td>
<td>AWPB</td>
<td>American Wood Preservers Bureau</td>
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<tr>
<td>32.</td>
<td>AWPI</td>
<td>American Wood Preservers' Institute</td>
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<td>33.</td>
<td>AWS</td>
<td>American Welding Society</td>
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<td>34.</td>
<td>AWWA</td>
<td>American Water Works Associations</td>
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<tr>
<td>35.</td>
<td>BHMA</td>
<td>Builders Hardware Manufacturers' Association</td>
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<tr>
<td>36.</td>
<td>CBMA</td>
<td>Certified Ballast Manufacturers' Association</td>
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<td>37.</td>
<td>CDA</td>
<td>Copper Development Association</td>
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<td>38.</td>
<td>CGA</td>
<td>Compressed Gas Association</td>
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<tr>
<td>39.</td>
<td>CISPI</td>
<td>Cast Iron Soil Pipe Institute</td>
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<td>40.</td>
<td>CMAA</td>
<td>Crane Manufacturers' Association of America</td>
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<tr>
<td>41.</td>
<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
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<tr>
<td>42.</td>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>43.</td>
<td>ETL</td>
<td>Engineering Test Laboratories</td>
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<td>44.</td>
<td>FCC</td>
<td>Federal Communications Commission</td>
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<td>45.</td>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>46.</td>
<td>FGMA</td>
<td>Flat Glass Marketing Association</td>
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<tr>
<td>47.</td>
<td>FM</td>
<td>Factory Mutual Association</td>
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<tr>
<td>48.</td>
<td>FS</td>
<td>Federal Specification</td>
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<tr>
<td>49.</td>
<td>GA</td>
<td>Gypsum Association</td>
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<tr>
<td>50.</td>
<td>HEW</td>
<td>Department of Health, Education and Welfare</td>
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<tr>
<td>51.</td>
<td>HI</td>
<td>Hydraulic Institute</td>
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<tr>
<td>52.</td>
<td>HMI</td>
<td>Hoist Manufacturers' Institute</td>
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<tr>
<td>53.</td>
<td>HUD</td>
<td>Department of Housing and Urban Development</td>
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<tr>
<td>54.</td>
<td>ICBO</td>
<td>International Conference of Building Officials</td>
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<td>55.</td>
<td>ICEA</td>
<td>Insulated Cable Engineers' Association</td>
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<tr>
<td>56.</td>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineers</td>
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<td>57.</td>
<td>IES</td>
<td>Illuminating Engineering Society</td>
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<td>58.</td>
<td>IFI</td>
<td>Industrial Fasteners Institute</td>
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<td>59.</td>
<td>IRI</td>
<td>Industrial Risk Insurers</td>
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<tr>
<td>60.</td>
<td>ISA</td>
<td>The Instrumentation Systems and Automation Society</td>
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<tr>
<td>61.</td>
<td>ISO</td>
<td>Insurance Services Office</td>
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</tbody>
</table>

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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. SDD 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
CITY OF PHOENIX: Water Services Department
PROJECT NAME: LIFT STATION 47 CIVIL & ELECTRICAL IMPROVEMENTS
PROJECT NUMBER: WS90400079

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<thead>
<tr>
<th></th>
<th>Acronym</th>
<th>Organization</th>
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<tbody>
<tr>
<td>97</td>
<td>SWI</td>
<td>Steel Window Institute</td>
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<tr>
<td>98</td>
<td>TEMA</td>
<td>Tubular Exchanger Manufacturers' Association</td>
</tr>
<tr>
<td>99</td>
<td>TCA</td>
<td>Tile Council of America</td>
</tr>
<tr>
<td>100</td>
<td>UL</td>
<td>Underwriters' Laboratories, Inc.</td>
</tr>
<tr>
<td>101</td>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>102</td>
<td>USPHS</td>
<td>United States Public Health Service</td>
</tr>
<tr>
<td>103</td>
<td>WCLIB</td>
<td>West Coast Lumber Inspection Bureau</td>
</tr>
<tr>
<td>104</td>
<td>WWEMA</td>
<td>Water and Wastewater Equipment Manufacturers Association</td>
</tr>
<tr>
<td>105</td>
<td>WWPA</td>
<td>Western Wood Products Association</td>
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</tbody>
</table>

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01452

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. Employ and pay for an independent testing laboratory to perform the specified services. Laboratory selected shall be subject to approval by the ENGINEER.

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 E329, "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 five copies of 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 1 - GENERAL

1.1 GENERAL

A. Responsible for all temporary construction facilities required for the Work. 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.
   5. Fire Protection.

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 degrees Fahrenheit, 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 Division 15, Mechanical, and Division 16, Electrical.
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 ++
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 Division 16, Electrical.

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, bypass pumping, temporary odor control system, 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 may be derived from the SRP service transformer. Coordinate with SRP (alex.babcock@srpnet.com) and SRP design standards: http://www.srpnet.com/electric/business/specs/ess.aspx. Refer to SRP ticket T2178392. Contractor call line: 602-236-0777.

B. Temporary power system shall be 480V and 208/120 volt, 60 Hz with sufficient capacity to provide service for construction use by all essential MOPO (Maintenance of Plant Operations) equipment as defined in Specification Section 01143 and trades and with the following minimum facilities:
1. 100-ampere frame with 50-ampere trip primary circuit breaker.
2. Two-pole safety switch, and a 240/120 volt, single phase, 3 wire distribution panel.
C. Temporary generator standby power is also required during time(s) when the existing generator is not operational. At no time shall the site be without automatic standby power AND a utility source.

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

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

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

I. Provide transformers as necessary to step down from 480 volt to 240/120 volt.

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.
CITY OF PHOENIX: Water Services Department
PROJECT NAME: LIFT STATION 47 CIVIL & ELECTRICAL IMPROVEMENTS
PROJECT NUMBER: WS90400079

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+++ END OF SECTION +++
SECTION 01512

TEMPORARY LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary lighting shall be provided by CONTRACTOR.

1.2 DEFINITIONS

A. Work Lighting: That required to provide adequate illumination for Work being performed.

B. Safety Lighting: That required to provide:
   1. Adequate illumination for safe movement of authorized persons throughout project.
   2. Adequate illumination for public safety.
   3. Special warning lighting for hazardous conditions.

C. Security Lighting: That required in protection of Work from unauthorized entry.

1.3 DESCRIPTION OF SYSTEM

A. Furnish and install temporary lighting that is required for:
   1. Construction needs.
   2. Safe and adequate working conditions throughout the Work.
   3. Public safety.
   5. Lighting for temporary office, storage, and construction buildings.

B. Lighting Intervals:
   1. Work Lighting:
      b. All stairs: Ten foot candles.
      c. Construction Plant and Shops: Ten foot candles.
      d. For Detail and Finishing Work: Twenty foot candles.
      e. For Detailed Testing and Inspection: Thirty foot candles.
      f. For First Aid Stations: Thirty foot candles.
      g. Operating areas: One 300-watt lamp per 15 foot on centers.
2. Safety Lighting:
   a. General: Five foot candles, minimum.
   b. For Hazardous Conditions: As required by applicable codes.
3. Night Security Lighting: Provide over area within 50 feet of any portion of construction

C. Periods of Service:
   1. Work Lighting: Continuous from 15 minutes prior to 15 minutes past scheduled Work hours on scheduled Work days.
   2. Safety Lighting:
      a. Within Project site: At all times authorized personnel are present.
      b. Public areas: At all times.

D. Maintain strict supervision of use of temporary lighting. Enforce conformance with applicable standards and safe practices and prevent abuse of services.

1.4 POWER

A. As specified in Section 01511, Temporary Electricity.

1.5 COSTS OF INSTALLATION AND OPERATION

A. Electrical contractor shall pay costs of Temporary Lighting, including costs of installation, maintenance, and removal.

B. Power Costs: As specified in Section 01511, Temporary Electricity.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electrical Code (NEC) current adoption, and City of Phoenix – Amendments to the National Electrical Code.

1.7 USE OF OWNER'S EXISTING SYSTEM

A. Existing systems cannot be used for temporary lighting.

1.8 USE OF PERMANENT SYSTEM

A. Secure OWNER’S written permission for use of system, indicating conditions of use.

B. Furnish and install temporary lamps for temporary lighting.

C. Lamps used shall be replaced upon Final Acceptance of the Work
1.9 MATERIALS

A. Comply with applicable provisions of Division 16, Electrical.

B. Materials and equipment may be new or used, but must be adequate for purposes intended and must not create unsafe conditions or violate requirements of applicable codes.

C. Provide all required facilities, including wiring, switches, accessories, and supports.

D. At CONTRACTOR'S option, patented specialty products may be used, if UL approved.

1.10 RECEPTACLES, FIXTURES

A. Standard products, meeting UL requirements.

B. Provide heavy-duty guards on fixtures.

C. Provide appropriate types of fixtures for environment in which used, in accordance with NEC and NEMA standards.

1.11 INSTALLATION

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

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

C. Modify and extend lighting as Work progress requires.

D. Locate to avoid interference with or hazards to:
   1. Work or movement of personnel.
   2. Traffic areas.
   4. Storage areas.
   5. Work for other contracts.

E. Install lighting switches at entrance to each area, or successive areas, so that progress to all areas of the Work may be made through lighted areas.

F. Install exterior security lighting.
   1. Illuminate entire Work site.
   2. Control lighting by photo-electric cell.
1.12 REMOVAL

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

B. Repair damage caused by temporary service and restore surfaces to specified, or original condition.

C. Immediately prior to completion of the Work, remove temporary lamps and install new lamps throughout.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01514

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 diameter supply service required for the work 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 Division 15, Mechanical.

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.

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 or permanent 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 01515

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

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 Division 15, Mechanical.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01550

ACCESS ROADS AND PARKING AREAS

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 01561, Security.

1.3 MAINTENANCE OF ROADS

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

B. Have all paved roads swept by mechanical sweeper, a minimum 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. Facility roads from entrance to work parking and work sites.
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.

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 01561

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 47 site for CONTRACTOR'S employees, material, tools, and equipment shall be from the designated construction entrance, or the lift station entrance only.

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 lift station 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 stated in Paragraph 1.2 A. above.
   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 01570

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 01580

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. Construction Sign.

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.
   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 01600

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 Systems, Division 15, Mechanical, Division 16, Electrical, and Division 17, Instrumentation. 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 relieve 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 01331, 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 B 62, NSF 372, 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. Acceptable compatible materials of construction for all elastomer materials are as follows:

<table>
<thead>
<tr>
<th>Process Fluid</th>
<th>Compatible Materials of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferric Chloride</td>
<td>Buna, EPDM, Teflon, Viton</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>Teflon, Viton</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>Teflon, Hypalon, Polypropylene, EPDM</td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td>Teflon, PVDF, Hypalon, Polypropylene</td>
</tr>
<tr>
<td>Polymer</td>
<td>Viton, Teflon</td>
</tr>
<tr>
<td>Methanol</td>
<td>Buna-N, Teflon</td>
</tr>
</tbody>
</table>

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.

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, three copies of a 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 or oil bath for wastewater 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 03600, Grout.

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 01630 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 10400, Identification Devices.
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 09900, Painting.

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 EQUIPMENT INFORMATION FORMS

A. Complete Form 01600-A found in Section 01331, Reference Forms, 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 01620

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, Sitework, through Division 17, Instrumentation.

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 05051, Anchor Bolts, Expansion Anchors, Toggle Bolts and Concrete Inserts.

B. Grouting shall be in accordance with Section 03600, Grout, and Section 01600, General Equipment Provisions.

1.3 TRANSPORTING, HANDLING AND INSTALLING EQUIPMENT AND MATERIALS

A. Conform to requirements of Section 01600, General Equipment Provisions, and Section 01651, Transportation and Handling of Equipment and Materials.

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 millwrights 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 01600, 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 Divisions 11, 13, 14, 15, 16, and 17 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 01600-A located in Section 01331, 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)
SECTION 01630

COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM TAGS

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 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.
   2. Provide a quantity of blank tags equal to 10% of the number of tags required above under article 1.1.B.1.

1.2 QUALITY ASSURANCE

A. Source Quality Control: All CMMS tags shall be the product of a single manufacturer.

1.3 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 inch.
   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. Fastener:
   1. Fasteners: 48-mil, stainless steel wire.
   2. Fastener Clamp: Zinc double ferrule wire clamp.
   3. Alternate fasteners must be approved by ENGINEER.

D. Layout:
   1. Refer to article 3.3.B, below for an example of the CMMS tag layout.

E. 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.

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:

<table>
<thead>
<tr>
<th>Service Description</th>
<th>Equipment Name</th>
<th>Serial Key</th>
<th>Asset ID</th>
<th>Initial Installed or Purchased Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Filter-to-Waste&quot;</td>
<td>&quot;Valve Actuator&quot;</td>
<td>&quot;SK:1234567&quot;</td>
<td>&quot;A-ID:9876543&quot;</td>
<td>&quot;2015&quot;</td>
</tr>
</tbody>
</table>
B. Example CMMS Tag Layout:

Filter-to-Waste Valve Actuator
SK:1234567
A-ID:9876543
2015

++ END OF SECTION ++
SECTION 01651

TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

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 01413, 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. 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.
E. 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 01661

STORAGE OF MATERIALS AND EQUIPMENT

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.

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 degrees Fahrenheit. 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 degrees Fahrenheit.

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.
   4. Piping, except PVC.
   5. Precast concrete items.

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 01413, 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 degrees Fahrenheit or above 100 degrees Fahrenheit, 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, VCI, 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 01721

PROTECTION OF THE WORK AND PROPERTY

PART 1 - GENERAL

1.1 DESCRIPTION

A. 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. 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. 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 02220.
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 01723

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, Site Work, through 17, Instrumentation, 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.

B. Request shall include:
   1. Identification of Project.
   2. Description of affected Work of CONTRACTOR and work of others.
   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.

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 01724

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 lift station flow will be necessary to make the connections, as outlined below:
   1. To install piping to a point where flows can be bypassed to the existing force mains through a temporary connection at the point where the new above ground piping will connect to the existing underground piping.

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 two weeks before shut-downs or by-passes are required.

D. Work Sequence: Sequence of Work and Schedule of Completion is specified under Section 01143, Coordination with OWNER'S Operations.

1.4 ELECTRICAL INSTALLATION

A. The CONTRACTOR is responsible for keeping the lift station operational 24 hours a day, seven days a week.
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 01731

INSTALLATION DATA

PART 1 - GENERAL

1.1 DESCRIPTION

A. Installation data is defined as written instructions; drawings; illustrative, wiring and schematic diagrams; diagrams identifying external connections, terminal block numbers and internal wiring; and all other such information pertaining to installation of materials and equipment that is not furnished with Shop Drawings. Included are all printed manufacturers installation instructions, including those that may be attached to equipment and for which approval by the ENGINEER is not required.

1.2 SUBMITTALS

A. Submit four copies of all such data to the ENGINEER for each piece of equipment which he furnishes and for all other construction products for which such information is available from manufacturer. Data shall be acceptably identified and accompanied with a letter of transmittal. Three copies shall be transmitted to the ENGINEER, in accordance with Section 01332, Shop Drawing Procedures, and one copy shall be transmitted to the ENGINEER at the Engineer's Field office. Copies shall be transmitted at least two weeks prior to the start of the equipment installation.

B. A copy of the installation data shall be provided in each copy of the Operation and Maintenance Manuals for the covered materials and equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION + +
SECTION 01740

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:
   2. Do not hold other materials more than three days if the temperature is expected to rise above 80 degrees Fahrenheit.
   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 01550.
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 01751

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 01821, 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 01752

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 least three, four-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.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>ANSI/ASME B40.1</td>
<td>Gauges Pressure Indicating Dial Type--Elastic Element</td>
</tr>
<tr>
<td>ASTM E 77</td>
<td>Method for Verification and Calibration of Liquid-in-Glass Thermometers</td>
</tr>
<tr>
<td>ASHRAE 41.8</td>
<td>Standard Methods of Measurement of Flow of Gas</td>
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<tr>
<td>City of Phoenix</td>
<td>Guidance Manual</td>
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<tr>
<td></td>
<td>Equipment Setup / System Testing Plan</td>
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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 01331 – Reference Forms.
      d. A list of all CMMS Tag numbers as provided in Section 01630, 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:

Metallurgical tests.
   a. Factory performance tests.
   b. Accelerometer recordings made during shipment.
   c. Field calibration tests.
   d. Field pressure tests.
   e. Field performance tests.
   f. Field operational tests.

(Each of these tests are required even though not specifically noted in detailed specification Section.)

4. Section 01331, 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 01320, 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 1/2-inch 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 16, Electrical, Wiring and piping, individual component, loop, loop commissioning and tuning testing, as specified in Division 17, Instrumentation, 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 consists of but not 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 16, 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 17, Instrumentation.
F. Electrical Resistance: Electrical resistance testing shall be in accordance with the requirements of Division 16, 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 01751, 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 14 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 01782, 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 seven 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 facility operating personnel for use in normal operation of the facility.

2. For the purpose of the Operational Availability Demonstration, the system shall be defined as consisting of the following systems and components:
   a. Yard Piping and appurtenances.
   b. Biofilter System.
   c. Electrical and Controls Systems.

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 seven 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 any 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 seven 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 seven 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 01781

OPERATIONS AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Operation 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 Operation and Maintenance Manuals are reviewed by the ENGINEER and the Operation and Maintenance Manuals have been turned over and approved by OWNER as per 1.1.D.3.

C. Definitions:
   1. Operation and Maintenance Data:
      a. The term "Operation and Maintenance Data" includes all product related information and documents which are required for preparation of the operation and maintenance manual. It also includes all data which shall accompany said manual as directed by current regulations of any participating government agency.
      b. Required Operation and Maintenance Data includes, but is not limited to, the following:
         1) A copy of the specification section in which the Operations and Maintenance Manual applies.
         2) 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.
         3) Complete, detailed written preventive maintenance instructions as defined below.
         4) Recommended spare parts lists, by generic title and identification number, and local sources of supply for parts.
         5) Written explanations of all safety considerations relating to operation and maintenance procedures, including Material Safety Data Sheets (M.S.D.S.s).
6) 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 01331 – Reference Forms, form number 01600-C. If multiple manufacturers of equipment are provided in a single manual, provide a separate form for each.

7) Copy of warranty bond and service contract, as applicable.

8) 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 17260 are to be provided in hard copy and electronically in AutoCAD version 2004 or newer.

10) Final test data, where applicable, shall be submitted as an appendix when completed.

11) Disassembly, reassembly, installation, alignment, adjustment, and checking instructions.

12) Provide installation data in accordance with Section 01731, Installation Data.

13) Written reference to CMMS Tag number, as specified under Section 01752, Equipment and System Startup and Performance Testing, paragraph 1.3.A.1.d., and as provided in Section 01630, Computerized Maintenance Management System Tags.

14) Provide the completed Equipment Information Forms, in accordance with the requirements of Section 01600, General Equipment Provisions. Form is located in Section 01331 – Reference Forms, form number 01600-A. If multiple manufacturers of equipment are provided in a single manual, provide a separate data sheet for each.


16) 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.

2. Preventive Maintenance Instructions:
   a. 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 condition and that the equipment or asset will reach its maximum potential life.

   b. The maintenance tasks frequency are driven by calendar, run-time, or meter reading.
D. Submittals:

   a. Submit operations and maintenance data to the ENGINEER within 60 days after approval of Shop Drawings, unless noted otherwise.
   b. Final approval of all O&M Manuals will only be provided after the OWNER's DOCUMENTS MANAGER, (Linda Webb (602) 534-9099) 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.
   c. Preliminary Copies:
      1) Number of preliminary copies: one hard copy(s) and one soft copies of each O&M Manual shall be submitted to the ENGINEER for review. The O&M Manual shall conform to the requirements as specified herein.
      2) 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 shall determine the timeline for the submittal review process.
   d. Final Copies:
      1) Number of Final Copies: one hard copy(s) and one soft copies of each manual.
      2) 14 days prior to placing the equipment into service submit all final hard copies and soft copies of the approved O&M Manual (except for field test data) to the ENGINEER.
      3) Soft copy shall be on a CD, "pdf" format – including "character recognition", 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 size of the pdf file shall be limited to 50 Mb and labeled with the title of the manual and volume number. Volumes shall be organized in a rational manner with the separation at a bookmark tab. CD's must be properly labeled with the following: Facility Name, Project Title, WS number, Specification Section # and Title of Manual. Labels must be computer generated. Hand written labels are not acceptable.
   e. 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 or larger, white in color, D-ring binders. Binders shall not be filled to more than 3/4 maximum of their capacity. Non-uniform binders will not be acceptable. Identify each binder with the following:
   i. Title "OPERATING AND MAINTENANCE INSTRUCTIONS".
   ii. Title of Project.
   iii. Specification Section Number and Title.
   iv. Name of the Provider of the Manual.
   v. WSD WS#.

4) Coordinate with the ENGINEER and OWNER to develop a comprehensive, practical, and consistent indexing system for the Operations and Maintenance Manuals. The ENGINEER and the OWNER shall review the indexing system before any manuals are submitted in draft form.

5) 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.

6) Provide a Table of Contents for each binder. 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.

7) 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.

8) Indicate all components of the equipment on catalog pages by highlighting or some other clearly definable medium for ease of identification.

f. 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 Operations and Maintenance Manuals.
   2) Three 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
2. Preventive Maintenance Instruction Submittal
   a. All preventive maintenance instruction described above in paragraph
      1.1.C.2 shall be provided to the ENGINEER separate from the Operations
      and Maintenance Manual submittal. The submittal timeline shall be
      determined by the ENGINEER; however, the City requires that all new
      assets and their preventive maintenance tasks are documented into the
      CMMS when the assets are ready for the commissioning process.
   b. Preventive maintenance information shall be reviewed and approved by
      the department's Asset Management Group. The information shall be per
      the asset's manufacturer's recommendation and includes, but is not limited
      to, the following:
      1) The manufacturer's written procedure on how to perform the
         preventive maintenance task with illustrations for each preventive
         maintenance task including list of required specialty tools.
      2) Recommended schedule/frequency for execution of each preventive
         maintenance task.
      3) List all assets that need the specific preventive maintenance task.
      4) Estimate of duration in hours to perform each preventive
         maintenance task. This value should only reflect just the time to
         perform the preventive maintenance task itself and not include any
         preparation/access time. It is also assumed that the staff has the
         necessary maintenance skill to perform the task.
      5) Number of staff needed perform the preventive maintenance task.
   c. The manufacturer's preventive maintenance task procedure shall be
      provided in electronic format (MS WORD file format or PDF with optical
      character recognition (OCR) feature). The ENGINEER shall format the
      preventive maintenance information and instructions into the MS EXCEL
      file format and arrange as indicated in the example below.

<table>
<thead>
<tr>
<th>Preventive Maintenance Description</th>
<th>Est. Hrs</th>
<th>Est. Staff</th>
<th>Freq.</th>
<th>Unit</th>
<th>Procedure No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change oil</td>
<td>2</td>
<td>1</td>
<td>12</td>
<td>mos</td>
<td>&quot;1234&quot;</td>
</tr>
<tr>
<td>Change seals</td>
<td>5</td>
<td>2</td>
<td>200</td>
<td>hrs</td>
<td>&quot;6789&quot;</td>
</tr>
<tr>
<td>----</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assets IDs</th>
<th>Asset Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345678</td>
<td>Raw Water Pumping, Pump No. 2</td>
</tr>
<tr>
<td>98765432</td>
<td>Finished Water Pumping, Pump No. 4</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
1.2 OPERATION AND MAINTENANCE

A. Operation and Maintenance data shall be provided for the following equipment at a minimum.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Specification Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check Valves</td>
<td>15114</td>
</tr>
<tr>
<td>Plug Valves, Air Valves</td>
<td>15112 &amp; 15119</td>
</tr>
<tr>
<td>Magnetic Meter &amp; Differential Pressure Transmitters</td>
<td>17052</td>
</tr>
<tr>
<td>HVAC Unit</td>
<td>15732</td>
</tr>
<tr>
<td>Electrical, Instrumentation &amp; Controls</td>
<td>Division 16 &amp; 17</td>
</tr>
<tr>
<td>Biofilter &amp; Appurtenances</td>
<td>13119</td>
</tr>
</tbody>
</table>

1.3 OPERATIONS AND MAINTENANCE TRANSMITTAL FORM

A. Upon receipt of the Vendor Operations & Maintenance Manual from the Manufacturer /Supplier, complete the CONTRACTOR review and submit the Operations and Maintenance Transmittal Form as specified in Section 01331, Form 01781-A to the ENGINEER. ENGINEER to complete the form and attach to the Manual when delivered to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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, Site Work, through Division 17, Instrumentation.

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. Label the Cover Sheet, Index and each supplemental sheets of each document "PROJECT RECORD" in 2-inch high printed letters.

   3. 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.

   4. Do not permanently conceal any Work until required information has been recorded.

   5. 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.

   6. 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 2004 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 01783

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 01783-A in Specification 01331 – 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 01785

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 01785 – Preventive Maintenance Data Submittal Form in Section 01331 – 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 01821 – 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

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>City Project #:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Cave Creek Water Reclamation Plant Rehabilitation&quot;</td>
<td>WS85123456</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineer:</th>
<th>Contractor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Preventive Engineering Company&quot;</td>
<td>&quot;Preventive Maintenance Constructor&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Asset Type Description:</th>
<th>Asset Manufacturer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Submersible Pumps&quot;</td>
<td>&quot;John Smith Pump Company&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preventive Maintenance Task Description</th>
<th>Est. Hrs</th>
<th>Est. Staff</th>
<th>Freq.</th>
<th>Frequency Unit (Days or Hrs)</th>
<th>Preventive Maintenance Procedure MS WORD File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Change oil</td>
<td>2</td>
<td>1</td>
<td>185</td>
<td>Days</td>
<td>&quot;1234&quot;</td>
</tr>
<tr>
<td>2. Annual Inspection</td>
<td>4</td>
<td>2</td>
<td>365</td>
<td>Days</td>
<td>&quot;6789&quot;</td>
</tr>
<tr>
<td>3. Major overhaul</td>
<td>8</td>
<td>2</td>
<td>1500</td>
<td>Hrs</td>
<td>&quot;xyz&quot;</td>
</tr>
<tr>
<td>4. ---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assets IDs</th>
<th>Asset Description</th>
<th>Max. Life (yrs)</th>
<th>Warranty Start Date</th>
<th>Warranty End Date</th>
<th>Warranty Duration (Mos)</th>
<th>Warranty Certificate Reference No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345678</td>
<td>Raw Water Pumping, Pump No. 2</td>
<td>10</td>
<td>09/15/2014</td>
<td>09/15/2015</td>
<td>12</td>
<td>&quot;jklmn&quot;</td>
</tr>
<tr>
<td>98765432</td>
<td>Finished Water Pumping, Pump No. 4</td>
<td>15</td>
<td>01/01/2014</td>
<td>01/01/2017</td>
<td>36</td>
<td>&quot;a12345&quot;</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01810

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 01143, Coordination with OWNER'S Operations. Work under this Section shall not start until the Work under Section 01143, Coordination with OWNER'S Operation, Section 01751, Starting and Placing Equipment in Operation, Section 01752, Equipment and System Start-Up and Performance Testing; Section 01781, Operation and Maintenance Data, Section 01782, Record Documents and Section 01821, Instruction of Operations and Maintenance Personnel. Also, Special Tests as defined under the individual technical specifications, Divisions 1 to 17 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.

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 01821, 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:

<table>
<thead>
<tr>
<th>Work/Work Area</th>
<th>Commissioning Requirements</th>
<th>Commissioning Duration (Calendar Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Sensors, Field Instruments,</td>
<td>All instruments in manual (local) and semi automatic modes of operation</td>
<td>30 consecutive uninterrupted days</td>
</tr>
<tr>
<td>electrical lineup, blower, drip irrigation system.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 01630 - 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 facility 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.
   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 01821

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 operations 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 01600, General Equipment Provisions, Section 01620, Installation of Equipment, Section 01751, Starting and Placing Equipment in Operation, and Section 01752, 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 01751, Starting and Placing Equipment in Operation, and Section 01752, Equipment and System Startup and Performance Testing.

H. Submit a copy of this Section 01821, 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 40 days prior to commencement of training. Lesson plans shall be approved a minimum of 14 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 operations 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 40 days prior to the requested training date. Form is located in Section 01331 – Reference Forms, form number 01821-B.
   5. There shall be separate "Operations" 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 01785 – 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 operations 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.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Section</th>
<th>Training Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter &amp; Appurtenances</td>
<td>13119</td>
<td>4</td>
</tr>
</tbody>
</table>

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 02145

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 and
dewatering of sewers for rehabilitation. 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. Prove 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 water or sewage
flows in excess of 1.7 mgd.

1.2 SUBMITTALS

A. 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.
   1. 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.
   2. Capacities of pumps, prime movers, and standby equipment.
3. Design calculations proving adequacy of the system and selected equipment sealed by a Professional Civil Engineer, registered in the State of Arizona.


5. Staffing Plan.


7. Spill Response 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 than 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 from 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 IN THE PROJECT PIPELINE

A. The following paragraph provides estimated peak daily dry weather flow information for the project pipeline. The information was obtained from the City of Phoenix. For questions pertaining to this information contact the City of Phoenix, Water Services Department, 200 West Washington Street, Phoenix, Arizona, during normal business hours.

B. The approximate estimated dry weather low flow, average daily dry weather flow and peak dry weather flow for Lift Station 47 are listed below in Table 1. 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.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry Weather Flow Estimates</strong></td>
</tr>
<tr>
<td>Project</td>
</tr>
<tr>
<td>Lift Station 47</td>
</tr>
</tbody>
</table>

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 greater 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.

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 02220

DEMOLOITIONS

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, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical equipment, paving, 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.
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 Section 01143, Coordination with OWNERS 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 Division 15, Mechanical.

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 15050, Piping Systems, and Section 15051, 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 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 02315, Structural Excavation and Backfill.

++ END OF SECTION ++
SECTION 02315

STRUCTURAL 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.
   5. 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.
   6. Perform all earthwork as specified in this Section.

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 01452, 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. 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.

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) Crossing paved roads: Two locations along each crossing.
      b) Under pavement cuts or within two feet of pavement edges: One location every 100 linear feet.
      c) Compaction test shall be taken at least every 2 feet of total lift and 100 feet lineally.
   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 1,000 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) 5 linear feet of trench backfill.
   2) 2 cubic yards of structural backfill.
   3) 100 cubic yards of embankment work.
   4) 5 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. 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 A36, Specification for Structural Steel.
   2. ASTM A328, Specification for Steel Sheet Piling.
   3. ASTM D422, Method for Particle-Size Analysis of Soils.
   5. ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil.
   6. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   8. ASTM D2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
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: Refer to Section 00700, General Conditions, and Section 00800, 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 by CONTRACTOR. Data is solely made available for the convenience of CONTRACTOR.
   1. 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 02220, 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. 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 D698 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 D698 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, fill for vaults and asphaltic pavements shall be crushed aggregate conforming to the requirements below:

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<th>Sieve Sizes (Square Openings)</th>
<th>Percentage by Weight Passing Sieve</th>
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<td>10 to 40</td>
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<td>No. 200</td>
<td>3 to 12</td>
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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 02318, 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.

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. 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.
   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,
comparisons 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'S Dewatering System will discharge to sewer, 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.
5. Meter the quantity of water discharged in a manner acceptable to the Arizona Department of Water Resources.
6. The discharged water from the Dewatering System shall be purchased from the Arizona Department of Water Resources at the prevailing rate.

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 A328. Steel for soldier piles, wales and braces shall be new or used and shall conform to ASTM A36.
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. 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.

8. Safe and satisfactory sheeting, shoring, and bracing shall be the entire responsibility of CONTRACTOR.

9. All municipal, County, State, and Federal ordinances, codes, regulations and laws shall be observed.

B. 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 02318, 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.
   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. The CONTRACTOR shall use half-sack slurry for backfill to spring line.

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.
### Required Minimum Density-Percent Compaction (ASTM D698) & *Maximum Uncompacted Lift (inches)*

<table>
<thead>
<tr>
<th>Material</th>
<th>Required Minimum Density-Percent Compaction (ASTM D698)</th>
<th>*Maximum Uncompacted Lift (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subgrade and Subbase Fill:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below concrete slabs on grade</td>
<td>95</td>
<td>8</td>
</tr>
<tr>
<td>Native soils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Not to be used in top 12 inches)</td>
<td>90-95</td>
<td>8</td>
</tr>
<tr>
<td>Below base of footings or mats, structural slabs and tank floors</td>
<td>95</td>
<td>8</td>
</tr>
<tr>
<td>Below asphalt concrete paving</td>
<td>95</td>
<td>12</td>
</tr>
<tr>
<td><strong>Structural Backfill:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 5 feet below final grade</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>Less than 5 feet below grade</td>
<td>95</td>
<td>8</td>
</tr>
<tr>
<td>Native soils</td>
<td>90-95</td>
<td>8</td>
</tr>
<tr>
<td><strong>Aggregate Base Course:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below concrete slabs or mats</td>
<td>95</td>
<td>8</td>
</tr>
<tr>
<td>Below asphalt paving</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>Valve pit</td>
<td>97</td>
<td>8</td>
</tr>
<tr>
<td>Trench Backfill, below and above ductbanks</td>
<td>95</td>
<td>12</td>
</tr>
</tbody>
</table>

* 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, ±two percent, with the following exceptions: under slab fill and 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.

1. **Contractor**'s testing service shall perform tests necessary to provide data for selection of fill material and control of placement water content.

2. 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.

3. 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 recompression until acceptable fill is provided.
3.10 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 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.

C. Compaction:
   1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.11 PAVEMENT SUBBASE COURSE

A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.

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.

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.
3.14 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

A. 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.

3.12 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.

++ END OF SECTION ++
SECTION 02318
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 D75 and ASTM C136.

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 15051, 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 C131, 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 D448.

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 D448 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 3/4 inch minus, supplied from 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 02315, 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 03100

CONCRETE FORMWORK

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 03300, Cast-In-Place Concrete, and Section 03200, Concrete Reinforcement.

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. 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 C805, Test Method for Rebound Number of Hardened Concrete.

C. Allowable Tolerances:
1. Construct formwork to provide completed concrete surfaces complying with
tolerances specified in ACI 347, Chapter 3.3, except as otherwise specified.

D. 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:
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. 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 03251, Concrete 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.

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.

C. 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.

<table>
<thead>
<tr>
<th>Temperature (F)</th>
<th>Over 95°F</th>
<th>70°F-95°F</th>
<th>60°F-70°F</th>
<th>50°F-60°F</th>
<th>Below 50°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Walls</td>
<td>1 day</td>
<td>1 day</td>
<td>2 days</td>
<td>3 days</td>
<td>Do not remove forms until site-cured test cylinder develops</td>
</tr>
<tr>
<td>b. Columns</td>
<td>2 days</td>
<td>1 day</td>
<td>3 days</td>
<td>4 days</td>
<td>7 days</td>
</tr>
<tr>
<td>c. Beam Soffits</td>
<td>7 days</td>
<td>4 days</td>
<td>5 days</td>
<td>6 days</td>
<td>7 days</td>
</tr>
<tr>
<td>d. Slabs 5 in.</td>
<td>7 days</td>
<td>5 days</td>
<td>6 days</td>
<td>7 days</td>
<td>75% of 28-day strength.</td>
</tr>
<tr>
<td>thick or less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Slabs over</td>
<td>7 days</td>
<td>6 days</td>
<td>7 days</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>5 in. thick</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Removal of Forms and Supports: Continue curing in accordance with Section 03300, Cast-In-Place Concrete.
B. When high-early strength concrete is specified, a schedule for removal of forms will be developed in the field from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI 301.

C. Form facing material shall remain in place a minimum of four days after concrete placement, unless otherwise approved by ENGINEER.

D. 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.

E. The time for removal of all forms will be subject to ENGINEER'S approval.

3.7 PERMANENT SHORES

A. Provide permanent shores as defined in ACI 347.

B. Reshores shall not be permitted.

3.8 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 ++
SECTION 03200

CONCRETE REINFORCEMENT

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, and welded wire fabric for concrete, 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 A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. ASTM A184, Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
   3. ASTM A185, Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   4. ASTM A496, Specification for Steel Wire, Deformed, for Concrete Reinforcement.
   5. ASTM A497, Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
   6. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   7. ASTM A706, Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
   8. ASTM A775, Specification for Epoxy-Coated Reinforcing Steel Bars.
  10. ACI 318, Building Code Requirements for Structural Concrete.
B. Allowable Placing Tolerances: Comply with ACI 318, Chapter 7 - Details of Reinforcement 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 01332, 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 03251, Concrete Joints, shall be submitted and approved before Shop Drawings for reinforcing steel are submitted.
   4. Description of reinforcing weld locations and weld procedures.

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 01651, Transportation and Handling of Materials and Equipment.

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 01661, Storage of Materials and Equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: ASTM A615, and as follows:
   1. Provide Grade 60 for all bars, unless indicated otherwise.
2. At beams and columns forming frames and wall boundary elements, where indicated on the Drawings, provide ASTM A706 or ASTM A615, Grade 60, with a maximum yield stress of 78,000 psi.

B. 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 CRSI Class 1 for maximum protection. The plastic coating on the legs shall extend at least 1/2-inch upward from the form surface.
      b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.
   4. Over waterproof membranes, use precast concrete chairs.

C. 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:
      a. HIT HY200, manufactured by Hilti Corporation.
      b. HSE 2411, manufactured by Hilti Corporation.
      c. Epcon System Ceramic 6, manufactured by ITW Ramset/Redhead.
      d. Powerfast, manufactured by Powers/Rawl Fastening System.
      e. Or equal.
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. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16-gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

E. 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.

F. 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 shall be as shown on the drawings.

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.

++ END OF SECTION ++
SECTION 03251

CONCRETE 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.
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 01332, Shop Drawing Procedures.

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:
      b. A.C. Horn, Incorporated.
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 D1752, 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 C920, 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):
   4. Tear strength (ASTM D624, die C): 75 pounds per inch of thickness, minimum.

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.

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 07920, 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.
3.5 ISOLATION JOINTS

A. Wherever a sidewalk or other slab on grade abuts a concrete structure and is not shown dowelled 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.

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 03252

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. ASTM A36, Specification for Structural Steel.
   4. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   5. ASTM A484/A 484M, Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
   6. ASTM A525, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

B. Expansion anchors and inserts shall be ICBO, UL, or FM approved.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Setting drawings and templates for location and installation of anchorage devices.
   2. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the anchorage devices.
   3. Copies of ICBO, UL, or FM reports certifying load carrying capacities and installation requirements for the anchorage devices.

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 ICBO Evaluation Report, or similar certifications by UL or FM, 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:

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<th>Bolt diameter</th>
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<th>Min Pull-Out Load (Pounds)</th>
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<tr>
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</table>

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.

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.
2.2 MATERIALS

A. Anchor Bolts:
   1. Provide carbon steel bolts complying with ASTM F1554, headed or non-headed type, unless otherwise indicated.
   2. Provide stainless steel bolts complying with ASTM F593, 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 F593, 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 F593, 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 F593, 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. Epoxy adhesive shall have a current ICC Evaluation Service report documenting acceptance under AC308 for use with cracked concrete and for the seismic design categories specified.
   6. Materials:
      a. In accordance with ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
      b. 2-component, 100 percent solids, insensitive to moisture, and gray in color.
c. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

7. Packaging:
   a. Furnished in side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Nozzle designed to thoroughly blend the components for injection from the nozzle directly into prepared hole.
   b. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

8. Manufacturers: One of the following 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 Anvil.
      b. No. 380D, 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. 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.

D. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by ENGINEER.

E. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
   3. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
   4. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

F. Hole diameter: Reinforcing bar diameter or all thread rod diameter plus 1/8 inch.

G. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling hole and fill the hole with drypack mortar. Relocate the hole to miss the obstruction and drill another hole. Repeat the above until the hole has been drilled to the required depth.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the structural member and endanger the stability of the structure. Drypack holes which hit obstructions and allow drypack to reach strength equal to the existing concrete before drilling adjacent holes. Epoxy grout may be substituted for drypack when acceptable to ENGINEER.
   3. When existing reinforcing steel is encountered during drilling and when acceptable to ENGINEER, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter.
   4. Bent bar reinforcing bars: Where edge distances are critical, and striking reinforcing steel is likely, and if acceptable to ENGINEER, drill hole at 10 degree angle or less from axis of reinforcing bar or all thread rod being installed.
H. Install reinforcing bars and all thread rods to depth, spacings, and locations as indicated on the Drawings.

I. Cleaning holes:
   1. Insert long air nozzle into hole and blow out loose dust. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
   2. Use a stiff bristle brush to vigorously brush hole to dislodge compacted drilling dust.
   3. Repeat step 1.
   4. Repeat above steps as required to remove drilling dust or other material that will reduce bond. The hole shall be clean and dry.

J. Cleaning reinforcing bars and all thread rods:
   1. Solvent clean reinforcing bar and all thread rods over the embedment length in accordance with SSPC SP-1 Solvent Cleaning. Provide an oil and grease free surface to promote bonding of adhesive to steel.
   2. Clean reinforcing bars and all thread rods over embedment length to bare metal. The reinforcing bars and all thread rods shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.

K. Filling hole with epoxy:
   1. Fill hole with epoxy before inserting the reinforcing bar or all thread rod. Fill hole with epoxy starting from bottom of hole. Fill hole without creating air voids.
   2. Fill hole with sufficient epoxy so that excess epoxy is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole. After inserting reinforcing bar or all thread rods, twist into holes until their final depth and direction are achieved.
   3. Do not install epoxy prior to receiving epoxy manufacturer's onsite training.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. All epoxy anchors shall be specially inspected as required by Chapter 17 of the International Building Code.

++ END OF SECTION ++
SECTION 03300

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. Concrete fill within structures.
      c. Unreinforced encasements.
      d. Curb and gutters.
      e. Sidewalks.
      f. Thrust blocks.
   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.
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 C31, Practice for Making and Curing Concrete Test Specimens in the Field.
13. ASTM C33, Specification for Concrete Aggregates.
15. ASTM C42, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
22. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
23. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
27. ASTM C494, Specification for Chemical Admixtures for Concrete.
28. ASTM C618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
29. ASTM C882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

31. ASTM E154, Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.


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 E329.
      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 C157 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.

H. Sample Panels:
   1. Not required.

I. Mock-up Panels:
   1. Not required.

J. Existing Sample Panels:
   1. Not required.

K. Designated Finish Sample Areas:
   1. Not required.

1.3 SUBMITTALS

A. Samples: Submit samples of materials as specified and as otherwise may be requested by ENGINEER, including names, sources and descriptions.

B. 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.

C. 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.

D. Submit notarized certification of conformance to referenced standards when requested by ENGINEER.

E. 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 C94, 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 C150, Type II. Type I may be used in lieu of Type II when acceptable to ENGINEER.
   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 C618 Class F, except as follows:
      a. The loss on ignition shall be a maximum of 4 percent.
      b. The maximum percent of sulfur trioxide (SO3) 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.

2.3 AGGREGATES

A. General:
   1. Aggregates shall conform to the requirements of ASTM C33 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. Water-Reducing Admixture: ASTM C494, 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.

C. High Range Water-Reducing Admixture (HRWR): ASTM C494, 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:

- Sikament series, as manufactured by Sika Corporation.
- Rheobuild series, as manufactured by Master Builders, Inc.
- Daracem-100, as manufactured by W.R. Grace & Company.
- Eucon 37 or Eucon 537, as manufactured by the Euclid Chemical Company.
- Or equal.

D. Set-Control Admixtures: ASTM C494, 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.

E. Calcium Chloride: Calcium chloride shall not be used.

F. 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:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Coarse Aggregate Size A</th>
<th>Size B</th>
<th>Minimum Cementious (lbs/cu yd)</th>
<th>Maximum W/C (%)</th>
<th>Slump (psi)</th>
<th>Air (%)</th>
<th>Min Comp Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type &quot;1&quot;</td>
<td>#57</td>
<td>#8</td>
<td>564</td>
<td>0.45</td>
<td>4&quot; Max. 6+/-1</td>
<td>4500</td>
<td></td>
</tr>
<tr>
<td>Type &quot;2&quot;</td>
<td>#57 or #67</td>
<td></td>
<td>517</td>
<td>0.50</td>
<td>4&quot; Max. 6+/-1</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>Type &quot;3&quot;</td>
<td>#57 or #67</td>
<td></td>
<td>564</td>
<td>0.40</td>
<td>4&quot; Max. 3 max</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>Type &quot;4&quot;</td>
<td>Any ASTM C33</td>
<td></td>
<td>&lt;------------------no requirements--&gt;</td>
<td></td>
<td></td>
<td>2000</td>
<td></td>
</tr>
</tbody>
</table>

1 Coarse aggregate size numbers refer to ASTM C33. 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 21-day drying age or at 28-day drying age shall be 0.039 percent or 0.045 percent, respectively. 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.
2.7 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents as specified in Section 03251, Concrete 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 C171.
   1. Waterproof paper.
   2. Polyethylene film.

D. Curing Compound: ASTM C309 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. Sealight 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:
2. Compressive strength at 28 days: 6000 psi (ASTM C109).
3. Bond strength at 28 days: 1800 psi (ASTM C882 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. Not required.

2.13 SHAKE-ON METALLIC HARDENER

A. Not required.

2.14 MOISTURE BARRIER

A. Moisture Barrier: ASTM E154:
   1. Provide moisture barrier cover over prepared base material where shown on the Drawings. Use polyethylene membrane not less than 8 mils thick, lapping at least 9-inches at joints.

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. Ready-Mix Concrete:
   1. Comply with the requirements of ASTM C94, 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.

C. 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 03251, Concrete 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 03251, Concrete 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 03600, Grout, 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 03251, Concrete
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 03251,
Concrete 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.

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 control 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 01450, On-Site Facilities for Testing Laboratory, and transportation required by the testing.

B. 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 C172.
      b. Slump: ASTM C143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
      c. Air Content: ASTM C231; one for every other concrete load at point of discharge, or when required by an indication of change.
      d. Compressive Strength Tests: ASTM C39; 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 C31; 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 C31.
      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 C42 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 a special finish such as terrazzo, ceramic tile or heavy duty concrete topping is required. In those cases, provide appropriate concrete finish.
   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 03600, Grout.

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 03600, Grout.

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.
SECTION 03600

GROUT

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).

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.

<table>
<thead>
<tr>
<th>Application</th>
<th>Type of Grout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam and column (1 or 2 story) base plates and precast concrete bearing less than 16-inches in the least dimension.</td>
<td>Non-shrink Class II</td>
</tr>
<tr>
<td>Column base plates and precast concrete bearing (greater than 2 story or larger than 16-inches in the least dimension).</td>
<td>Non-shrink Class I</td>
</tr>
<tr>
<td>Base plates for storage tanks and other non-motorized equipment and machinery less than 30 horsepower.</td>
<td>Non-shrink Class I</td>
</tr>
<tr>
<td>Machinery over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibration.</td>
<td>Non-shrink Class III</td>
</tr>
<tr>
<td>Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.</td>
<td>Non-shrink Class II (Class I where placement time exceeds 15 minutes)</td>
</tr>
</tbody>
</table>
Application | Type of Grout
--- | ---
All anchor bolts and reinforcing steel set in grout. | Refer to Section 03200, Concrete Reinforcement, and Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

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 C33, Specification for Concrete Aggregates.
10. ASTM C882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
11. ASTM C937, Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.
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 C109 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 C579, 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. Not required.

   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 C1107, 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 C1107 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 C939.
      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 C1107 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 C230, 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 C827 (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 C531.
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 C1181.
6. The seven day compressive strength shall be a minimum of 14,000 psi when tested in accordance to the requirements of ASTM C579.

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 C882.

9. The effective bearing area shall be a minimum of 95 percent.

2.2 CURING MATERIALS

A. Curing materials shall be as specified in Section 03300, 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.

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 03300, Cast-In-Place Concrete.
4. Grout shall be cured following manufacturer's instructions for prepackaged grout and the requirements in Section 03300, 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.
PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to repair or rehabilitate all existing concrete members and surfaces identified in the Contract Documents.
   2. Repair all damage to new concrete construction as specified herein, except that where such repairs are specified in Section 03300, Cast-in-Place Concrete.

B. Coordination:
   1. Review installation procedures in the following Section and coordinate the installation of items that must be included with the repair and rehabilitation of concrete.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:
   3. ASTM C882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
   6. ASTM D903, Test Method for Peel or Stripping Strength of Adhesive Bonds.

B. Construction Tolerances: Construction tolerances shall be as specified in Section 03300, Cast-in-Place Concrete, except as specified herein and elsewhere in the Contract Documents.
1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit manufacturer's product information and recommended placement procedures for all repair materials.
   2. Submit Shop Drawings, when requested by ENGINEER, to show all methods for supporting existing structures, pipes, etc., during demolition and repair activities. Comply with the requirements of Section 01332, Shop Drawing Procedures.
   3. Copies of certificates that show that the repair materials are approved by the National Sanitation Foundation (NSF) for use on surfaces, which are in contact with potable water.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Conform to the requirements of Section 01651, Transportation and Handling of Materials and Equipment, and supplementary requirements below.
   2. Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information.
      a. Name or title of material.
      b. Manufacturer's stock number and date of manufacture.
      c. Manufacturer's name.

B. Storage of Materials:
   1. Conform to the requirements of Section 01661, Storage of Materials and Equipment, and supplementary requirements below.
   2. Storage only acceptable project materials on project site.
   3. Store in a suitable location approved by ENGINEER. Keep area clean and accessible.
   4. Restrict storage to repair materials and related equipment.
   5. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.

C. Handling of Materials:
   1. Conform to the requirements of Section 01651, Transportation and Handling of Materials and Equipment, and supplementary requirements below.
   2. Handle materials carefully to prevent inclusion of foreign materials.
   3. Do not open containers or mix components until necessary preparatory Work has been completed and application Work will start immediately.
PART 2 - PRODUCTS

2.1 REPAIR MORTAR

A. Repair mortar shall be a prepackaged cement based product specifically formulated for the repair of concrete surface defects. The repair mortar shall be a two-component polymer-modified, portland cement, fast setting, trowel-grade mortar. The repair mortar shall be enhanced with a penetrating corrosion inhibitor and shall have the following properties:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Value</th>
<th>ASTM Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength (minimum)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 1 day</td>
<td>2000 psi</td>
<td>C109</td>
</tr>
<tr>
<td>at 28 days</td>
<td>6000 psi</td>
<td></td>
</tr>
<tr>
<td>Bond Strength (minimum)</td>
<td></td>
<td>C882*</td>
</tr>
<tr>
<td>at 28 days</td>
<td>1800 psi</td>
<td></td>
</tr>
</tbody>
</table>

* Modified for use with repair mortars.

B. Where the least dimension of the placement in width or thickness, exceeds 4-inches, the repair mortar shall be extended by addition of aggregate as recommended by the manufacturer.

C. Product and Manufacturer: Provide one of the following:

1. SikaTop 122 Plus, SikaTop 123 Plus, or SikaTop 126 Plus, as manufactured by Sika Corporation.
2. Or equal.

2.2 JOINT REPAIR SYSTEM

A. Joint Repair System: The joint repair system shall consist of two components, an epoxy resin adhesive and hypalon sheeting.

1. Epoxy Resin Adhesive: Provide a two-component epoxy resin as follows:
   a. Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents and pigments. It shall not contain butyl glycidyl ether.
   b. Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments and accelerators.

2. Hypalon Sheeting: Provide Hypalon sheeting as follows:
   a. Hypalon sheeting shall consist of Hypalon rubber. It shall be perforated along the bonding edge to provide a mechanical key. It shall have the ability to be vulcanized with hydrocarbon solvent to permit its adhesion to an epoxy resin adhesive.
b. The sheeting shall be provided in 12-inch width with a thickness of 40 mils.

c. The sheeting shall be able to be lapped or seamed by heat or by anaaromatic hydrosolvent strip.

d. The sheeting shall be supplied with a removable center expansion strip.

3. Product and Manufacturer: Provide one of the following:
   a. Sikadur Combiflex, as manufactured by Sika Corporation.
   b. Or equal.

2.3 EXPOSED REBAR REPAIR

A. The exposed reinforcing repair system shall consist of two components, a first application of a corrosion inhibitor and then a final application of a protective slurry mortar.

B. Corrosion Inhibitor:
   1. The corrosion inhibitor shall penetrate the hardened concrete surface and form a protective layer on the reinforcement. It shall have the following properties:
      a. The product shall not change the substrate's color, appearance, or texture.
      b. Penetration (SNMS Analysis): 1/10 to 4/5 inches/day.
      c. Coating thickness (XPS and SIMS Analysis): 100 to 1000 angstroms.
      e. Chloride Displacement (XPS and SIMS Analysis): Passes.
      g. The product must not form a vapor barrier.
      h. The product must be environmentally sound.
      i. Post-application verification (Chromatography Plate Test): Passes.
   2. Product and Manufacturer: Provide one of the following:
      a. Sika FerroGard 903, as manufactured by Sika Corporation.
      b. Or equal.

C. Protective Slurry Mortar:
   1. Protective slurry mortar shall be a two-component, polymer-modified, cementitious waterproofing and protective slurry mortar. Provide two coats at a rate of 50 sq. ft./gal./coat.
   2. Product and Manufacturer: Provide one of the following:
      a. Sikatop Seal 107, as manufactured by Sika Corporation.
      b. Or equal.
PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which repair 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 GENERAL

A. Surface Preparation:
   1. The entire area to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping, abrasive blasting or hydroblasting. The surface shall be further roughened as specified herein. Where non-shrink grout or repair mortar is used, any additional surface preparation steps recommended by the manufacturer shall be performed.
   2. Where repair concrete, shotcrete, or cement grout is used, and a bonding agent is not required, or where the repair mortar or non-shrink grout manufacturer recommends a wet or saturated surface, water shall be delivered to the surface continuously for a minimum of four hours. Where large surface areas are to be repaired, fog spray nozzles mounted on stands shall be provided in sufficient numbers such that the entire surface to be repaired is in contact with the fog spray cloud. The concrete shall be prevented from drying until after the repair operation is completed. Unrepaired surfaces shall be rewetted by water spray on at least a daily basis. Should more than four days elapse without rewetting the unrepaired surfaces, the original saturating procedure shall be repeated. All standing water in areas to be repaired shall be removed prior to placement of repair material. Means to remove excess water from the structure shall be provided.
   3. Where the repair material manufacturer recommends the use of an epoxy-bonding agent, the recommendations of both the repair material and bonding agent manufacturers shall be followed.

B. Care shall be taken to fully consolidate the repair material, completely filling all portions of the area to be filled.

C. The repair surface shall be brought into alignment with the adjacent existing surfaces to provide a uniform, even surface. The repair surface shall match adjacent existing surfaces in texture and shall receive any coatings or surface treatments which had been provided for the existing surface.
D. Curing:
   1. Curing of repair mortar and non-shrink grout shall be according to the manufacturer's recommendations except that the minimum cure period shall be three days.
   2. Curing of other materials shall be according to Section 03300, Cast-in-Place Concrete.

3.3 TREATMENT OF SURFACE DEFECTS

A. Surface defects are depressions in a concrete surface which do not extend all the way through the member. The depressions can result from the removal of an embedded item, the removal of an intersecting concrete member, physical damage, un repaired rock pockets created during original placement, or spalls from corroded reinforcing steel or other embeds.

B. Preparation:
   1. All loose, damaged concrete shall be removed by chipping to sound material.
   2. Where existing reinforcing bars are exposed, concrete shall be removed to a minimum of 1-inch all around the bars. If the existing bars are cut through, cracked, or the cross sectional area is reduced by more than 25 percent, the ENGINEER shall be notified immediately.
   3. The perimeter of the damaged area shall be score cut to a minimum depth of 0.5-inch and a maximum depth to not cut any existing reinforcing steel. Existing concrete shall be chipped up to the score line so that the minimum thickness of repair mortar is 0.5-inch.

C. Repair Material:
   1. Repair of surface defects in members, which are normally in contact with water or soil, or in the interior surfaces of enclosed chambers that contain water shall be made only with repair mortar.
   2. Repair of other surface defects may be by the application of repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.4 PATCHING OF HOLES IN CONCRETE

A. For holes larger than 48-inches, refer to the Drawings for reinforcement details.

3.5 PATCHING OF LINED HOLES

A. This Section applies to those openings which have embedded material over all or a portion of the inside edge. Unless indicated to remain in place on the Drawings or by the ENGINEER, such embedded materials shall be removed and the remaining hole repaired as specified above. The requirements for repairing holes in concrete specified above shall apply as modified herein.
B. Where embedded material is allowed to remain, it shall be trimmed back a minimum of 2-inches from the concrete surface. The embedded material shall be roughened or abraded to promote good bonding to the repair material. Any substance that interferes with good bonding shall be completely removed.

C. Any embedded item that is not securely and permanently anchored into the concrete shall be completely removed.

D. Embedded items which are larger than 12-inches in their least dimension shall be completely removed, unless they are composed of a metal to which reinforcing steel can be welded. Where reinforcement is required, it shall be welded to the embedded metal.

E. The following additional requirements apply to concrete members which are in contact with water or soil.
   1. Lined openings, which are less than 4-inches in their least dimension, shall be filled with epoxy grout.
   2. Lined openings which are greater than 4-inches, but less than 12-inches in their least dimension, shall be coated with an epoxy bonding agent prior to being filled with Class I non-shrink grout.
   3. Lined openings which are greater than 12-inches in their least dimension shall be coated with an epoxy bonding agent and shall have a hydrophilic rubber waterstop or bead of hydrophilic sealant installed to the interior of the opening at the wall centerline, as required by Section 03251, Concrete Joints, prior to being filled with any approved repair material.

3.6 REPAIR OF DETERIORATED CONCRETE

A. This Section pertains to concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, and damage due to chemical attack. The only material acceptable for surface repair is repair mortar as specified herein. Where the repaired surface is to be subsequently covered with a PVC liner material, the finishing details shall be coordinated with the requirements of installing the liner material.

B. Surface Preparation:
   1. All loose, broken, softened, and acid contaminated concrete shall be removed by abrasive blasting and chipping down to sound, uncontaminated concrete.
   2. When the removal of deteriorated concrete is completed, CONTRACTOR to notify the ENGINEER, in writing. Two weeks shall be scheduled for the ENGINEER to inspect the surface, perform testing for acid contamination, determine if additional concrete must be removed, and to develop any special repair details that may be required. Should it be determined that additional concrete must be removed to reach sound, uncontaminated material, another two week period shall be scheduled for further evaluation after the end of the additional removal.
3. Additional surface preparation shall follow the recommendations of the repair mortar manufacturer.

4. Isolated areas of exposed reinforcing bars shall be treated as required for repair of surface defects. If extensive areas of reinforcement are uncovered after removal of deteriorated concrete, repair methods shall be as determined by the ENGINEER.

C. Repair Mortar Placement:
1. The procedures recommended by the manufacturer for the mixing and placement of the repair mortar shall be followed.
2. After the initial mixing of the repair mortar, additional water shall not be added to change the consistency should the mix begin to stiffen.
3. Repair mortar shall be placed to a minimum thickness as recommended by the manufacturer, but not less than 0.50-inch. Where removal of deteriorated concrete results in a repair thickness of less than 0.5-inch to return to original concrete surface location in isolated areas totaling less than ten percent of the total repair area, additional concrete shall be removed to obtain the 0.5-inch thickness. Where the area with repair thickness of less than 0.5-inch exceeds ten percent of the total repair area, notify the ENGINEER. In any case, repair mortar shall be added so that the minimum cover over existing reinforcing steel is 2-inches. Do not place repair mortar so as to create locally raised areas. Where there is a transition with wall surfaces which are not in need of repair, the repair mortar shall not be feathered at the transition. A score line shall be sawcut to not less than the minimum repair mortar depth and concrete chipped out to it to form the transition. Care shall be taken to not cut or otherwise damage any reinforcing steel.
4. The repair mortar shall be placed to an even, uniform plane to restore the member to its original surface. Tolerance for being out of plane shall be such that the gap between a 12-inch straight edge and the repair mortar surface does not exceed 0.125-inch and the gap between a 48-inch straight edge and the repair mortar surface does not exceed 0.25-inch. This shall apply to straight edges placed in any orientation at any location.

D. Finishing:
1. The repair mortar shall receive a smooth, steel trowel finish.
2. When completed, there shall be no sharp edges. All exterior corners, such as at penetrations, shall be made with a 1-inch radius. All interior corners shall be square except corners to receive PVC lining shall be made with a 2-inch repair mortar fillet.

E. Curing:
1. Curing shall be performed as recommended by the repair mortar manufacturer, except that the cure period shall be at least 24 hours and shall be by means of a continuous fog spray. If the manufacturer recommends the use of a curing compound, no material shall be used that would interfere
with the bond of the protective coating system or adhesive used for placing PVC lining, where required.

3.7 TREATMENT OF EXPANSION JOINT REPAIR

A. Surfaces to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping, abrasive blasting or hydroblasting.

B. Follow all other surface preparation and application specifications as recommended by manufacturer.

3.8 EXPOSED REBAR REPAIR

A. The entire area to be repaired shall have all corrosion, foreign materials, and unsound concrete by means of abrasive blasting or hydroblasting.

B. Surface shall be visually dry before application of the corrosion inhibitor. The corrosion inhibitor shall be placed liberally to achieve 100 sq ft/gal coverage in two or more coats by allowing it to soak into the substrate. The re-coat time between coats shall be a minimum of one hour. Apply by use of rollers, brushes, or hand-pressure spray equipment.

C. After the last coat of the corrosion inhibitor is applied, a minimum curing time of 24 hours is required.

D. High Pressure Wash all surfaces to remove filmy residue that is left on the surface by the corrosion inhibitor. Residue acts like bond breaker and must be removed before mortar coating.


3.9 FIELD QUALITY CONTROL

A. OWNER will employ a testing laboratory to perform field quality control testing. ENGINEER will direct the CONTRACTOR on the number of standard compression tests and specimens required as specified below, under the direct inspection by ENGINEER. Furnish all necessary assistance required by ENGINEER. Provide all labor, material and equipment required including rods, molds, thermometer, curing in a heated storage box, and all other incidentals required. Above will be subject to approval by ENGINEER. Furnish all necessary storage, curing, and transportation required by the testing.
B. Field tests of cement based grouts and repair mortar:
   1. Compression test specimens will be taken during construction from the first placement of each type of mortar or 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 repair mortar and non-shrink grout will be performed as specified in ASTM C109. A set of three specimens will be made for each test. Tests shall be made at 7 days, 28 days, and additional time periods as appropriate.
   3. All material, already placed, which fails to meet the requirements of these specifications, is subject to removal and replacement at the cost of CONTRACTOR.
   4. The cost of all laboratory tests on mortar and grout will be borne by the OWNER, however CONTRACTOR provide assistance to the ENGINEER in obtaining specimens for testing. The cost of any additional tests and investigation on Work performed which does not conform to the requirements of the specifications will be the CONTRACTOR's responsibility. Supply all materials necessary for fabricating the test specimens.

C. Repair Concrete: Repair concrete shall be tested as required in Section 03300, Cast-in-Place Concrete.

+++ END OF SECTION +++
SECTION 04060

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:
      b. Masonry cement mortars.
      c. Fire-resistant mortars.
      d. Fine grout.
      e. Coarse grout.
      f. Grout fill around reinforcement in masonry lintels and bond beams.
      g. Epoxy pointing mortar.
      h. Mortar waterproofing admixtures, inorganic pigments and other
         miscellaneous mortar components and additives.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Wherever a fire-resistance classification is
   shown or scheduled for unit masonry construction (4-hour, 3-hour and similar
   designations), proportion mortar and masonry grouts to comply with the
   requirements established by UL and other governing authorities.

B. Codes: Comply with the applicable requirements of the Phoenix Building Code for
   types of mortar work specified.

C. 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.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ANSI A 108.1, Installation of Ceramic Tile.
2. ASTM C5, Specification for Quicklime for Structural Purposes.
10. UL, Design Numbers U901 through U914.

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.

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 01651, Transportation and Handling of Materials and Equipment.

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 01661, Storage of Materials and Equipment.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement: Provide the following for Portland cement-lime mortars:
   1. ASTM C150:
      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 required to be compatible with the required colored mortar pigment selected by ENGINEER.
   3. Product and Manufacturer: Provide one of the following:
      a. Speed Portland Cement and Hi-Speed Portland Cement by Louisville Cement Company.
      c. Or equal.

B. Hydrated Lime: ASTM C207, Type S, or lime putty ASTM C5.

C. Sand Aggregates:
   1. ASTM C144, except for joints less than 1/4-inch use aggregate graded with 100 percent passing the No. 16 sieve.
   3. Course Aggregate for Grout: ASTM C404, Size No. 8 or Size No. 89.

D. Water: Free from injurious amounts of oils, acids, alkalis, or organic matter, and clean, fresh and potable.

2.2 MORTAR MIXES

A. General:
   1. Anti-Freeze Admixture or Agents: Not permitted.
   2. Calcium Chloride: Not permitted.

B. Fire Resistant Mortar:
   2. Proportion: Use one part Portland cement, three parts clean sand, and 15 percent hydrated lime (by cement volume)

C. Mortar for All Other Unit Masonry: Comply with ASTM C270, Table 2, except limit materials to those specified herein. Do not substitute ASTM C91 masonry cement for ASTM C150 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 C270: 1800 pounds per square inch.
      3) Maximum Air Content, ASTM C270: 18 percent.

D. 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.
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 C5.
   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 04201, 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 C91. 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 ++
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 and ties.
      b. Individual wire ties.
      c. Anchoring and positioning devices.
      d. 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. Requirements of Regulatory Agencies: Wherever a fire-resistance classification is shown or scheduled for unit masonry construction (4-hour, 3-hour and similar designations), provide masonry accessories complying with the requirements established by UL and other governing authorities.

C. Codes: Comply with the applicable requirements of the Phoenix Building Code for types of masonry accessories work shown and specified.

D. Source Quality Control: 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.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
2. ASTM A36, Specification for Carbon Structural Steel.
3. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
7. ASTM A366, Specification for Commercial Steel Sheet, Carbon, Cold-Rolled.
8. ASTM A569, Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
10. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
13. UL, Design Numbers U901 through U908.

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 01332, Shop Drawing Procedures.
   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 01651, Transportation and Handling of Materials and Equipment.

B. Storage of Materials: Store and cover materials to prevent damage, corrosion and deterioration. Comply with the requirements of Section 01661, Storage of Materials and Equipment.

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: Provide the following:
      a. All reinforcement, wire and ties of cold-drawn steel wire complying with ASTM A82 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 inch 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.

B. Anchoring Devices for Masonry: Provide the following, unless otherwise shown:
   1. General: Provide the following:
      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 A82, 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: Provide the following:
   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: Provide one of the following:
      1) #RB Series and #RB-Twin Series Rebar Positioners by Hohmann & Barnard, Incorporated
      2) Or equal.

C. Miscellaneous Masonry Accessories: Provide the following where shown:

1. Reinforcing Bars:
   a. Deformed carbon steel, ASTM A615, Grade 60 for bars No. 3 to No. 18, except as otherwise shown.
   b. Plain carbon steel, ASTM A663, Grade 80 where No. 2 bars are shown or required.

2. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, and as shown. Provide the following:
   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: Provide one of the following:
      1) Polytite Standard by Polytite Manufacturing Corporation.
      2) Or equal.

3. Masonry Control Joint Components: Provide the following:
   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:
         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 D2240, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
         1) Product and Manufacturer: Provide one of the following:
            a) #RS Series - Rubber Control Joints by Hohmann & Barnard, Incorporated.
            b) Or equal.
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4. Weep Holes: Provide the following:
   a. Rectangular 3/8-inch wide by 1-1/2-inches high 3-1/2-inches long clear butyrate tubes.
   b. Product and Manufacturer: Provide one of the following:
      1) #342 - Plastic Weep Holes by Hohmann & Barnard, Incorporated.
      2) Or equal.

5. Weep Vents: Provide the following:
   a. Provide injection molded flexible polyvinylchloride brick vents of custom color to match face brick mortar color with top flap, flexible side wings, vertical louvers and water ridges.
   b. Product and Manufacturer: Provide the following:
      1) Goodco Brick Vents by Williams Products, Incorporated.
      2) Or equal.

6. Cavity Fill Mesh: Provide the following:
   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: Provide one of the following:
      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. Coordinate location of all weld-on anchors and show same on structural steel Shop Drawings required under Section 05120, Structural Steel.

C. Weld anchor slots and other required accessories in place before shop priming of structural steel.

D. Prime all weld-on anchors and other accessories and passivate anchor coating as required and specified under Section 09900, Painting.

E. 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 the following:
   1. Section 04201, Unit Masonry Construction.

++ END OF SECTION ++
SECTION 04201

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. Requirements of Regulatory Agencies: Wherever a fire-resistance classification is
   shown or scheduled for unit masonry construction (4-hour, 3-hour, and similar
   designations), comply with applicable requirements for materials and installation
   established by UL and other governing authorities.

B. Codes: Comply with the applicable requirements of the Phoenix Building Code for
   the types of unit masonry construction Work shown.

C. 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.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. American Concrete Institute, ACI 530, Building Code Requirements for Masonry Structures.
2. American Concrete Institute, ACI 530.1, Specification for Masonry Structures.
4. Underwriters Laboratories Incorporated, UL Design No. U901 - Bearing Wall Rating-4 hr/Nonbearing Wall Rating-4 hr.
5. Underwriters Laboratories Incorporated, UL Design No. U902 - Bearing Wall Rating-4 hr.
6. Underwriters Laboratories Incorporated, UL Design No. U904 - Bearing Wall Rating-3 hr/Nonbearing Wall Rating-3 hr.
7. Underwriters Laboratories Incorporated, UL Design No. U905 - Bearing Wall Rating-2 hr/Nonbearing Wall Rating-2 hr.
8. Underwriters Laboratories Incorporated, UL Design No. U906 - Bearing Wall Rating-2 hr/Nonbearing Wall Rating-2 hr.
10. Underwriters Laboratories Incorporated, UL Design No. U909 - Nonbearing Wall Rating-3 or 4 hr.
13. Underwriters Laboratories Incorporated, UL Design No. U912 - Bearing Wall Rating-3 hr/Nonbearing Wall Rating-3 hr.
15. Underwriters Laboratories Incorporated, UL Design No. U914 - Bearing Wall Rating-3 hr/Nonbearing Wall Rating-3 hr.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Masonry control joint locations and details.
2. 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.

3. 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.

4. Comply with the requirements of Section 01332, Shop Drawing Procedures.

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 01651, Transportation and Handling of Materials and Equipment.

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 01661, Storage of Materials and Equipment.

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 columns or 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.
   2. Clay or shale unit masonry with suction in excess of 20 grams of water per 30 square inches per minute shall be sprinkled with heated water just prior to laying. Provide water temperature above 70°F when temperature of units is above 32°F. Water temperature shall be above 120°F when temperature of units is below 32°F.
   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. 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. Build interior masonry walls, visible from both sides in the finished Work, using two wythes of masonry. Glazed structural tile shall be continuous over the entire plan of the wall including walls, which continue behind fixtures, equipment, furniture, lockers and similar items.

3.4 LAYING MASONRY WALLS

A. General:
1. Mortar Types: Unless otherwise indicated, use mortar as specified in Section 04060, 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 exterior and interior 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. Bond and interlock each course of each wythe at corners.
   c. Do not use units with less than 8-inch horizontal face dimensions at corners or jambs.
5. Color and Texture:
   a. Lay all concrete unit masonry using mortar of natural color.
   b. Lay all glazed structural tile Work using mortar of natural color. Rake as specified to receive pointing mortar.
6. Glazed Structural Tile and Ground Face Concrete Masonry Units: Construct walls using two wythes of masonry to assure good workmanship on both sides of walls.
7. Hand select glazed structural tile and ground face masonry units to assure uniform continuity of finished surfaces from unit to unit. Glazed structural tile with misaligned face ceramic glazing shall be removed from the site.

B. Mortar Bedding and Jointing:
1. 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. Glazed Structural Tile: 1/4-inch.
   c. Prefaced Concrete Masonry Units: 1/4-inch.
2. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, except paint, unless otherwise shown.
3. 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 and for epoxy pointing mortar for glazed structural tile where required.
4. Concave-tool exterior joints below grade.
5. 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.

C. 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.

D. 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.
3. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of cavity fill mesh in the joint below and rod mortar or grout into core.
4. Where required by governing code requirements or to meet thickness to height ratio or to provide required fire-resistance, fill all cells of unit masonry construction solid with grout.

E. Horizontal Joint Reinforcing:
1. Provide continuous horizontal joint reinforcing as shown and specified. Refer to Section 04090, 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. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend units in accordance with manufacturer's written instructions for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

4. Space continuous horizontal reinforcing as follows:
   a. For multi-wythe walls, solid or cavity, which are structurally bonded by masonry headers or individual wire ties, space horizontal reinforcing 24-inches on centers vertically.
   b. For multi-wythe walls, solid or cavity, where continuous horizontal reinforcing also acts as structural bond or tie between wythes, space reinforcing as required by code, but not more than 16-inches on centers vertically.
   c. For single wythe walls, space reinforcing at 16-inches on centers vertically, unless otherwise shown.
   d. For parapets, space reinforcing at 8-inches on centers vertically, unless otherwise shown.

5. 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.

6. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the above.

F. Structural Reinforced Unit Masonry Construction:

1. Comply with requirements of ACI 530, ACI 530.1 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. For columns, piers and pilasters, provide a clear distance between vertical bars as shown, but not less than 1-1/2 times the nominal bar diameter or 1-1/2 inches, whichever is greater. Provide lateral ties.

6. 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.
7. Provide substantial and tight formwork and shores as required for temporary support of reinforced masonry elements. Design, erect, support, brace and maintain formwork.

8. 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.

9. 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.

10. 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. Girders and Beams: Ten days.
   b. Masonry Foundation Slabs: Seven days.
   c. Reinforced Masonry Soffits: Seven days.

G. 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.

5. High-Lift Grouting:

a. High-lift grouting technique may be used for the following structural reinforced unit masonry construction:

1) Two-wythe walls with grout spaces of 2-1/2 inches or greater width.
2) Columns, piers, or pilasters when no unit masonry fill is shown to be placed in reinforced grout space.

b. Place reinforcing and support in proper position, prior to laying of masonry units, except if shown to be placed in mortar joints, place as masonry units are laid. Place horizontal bars in grout spaces on same side of vertical bars.

c. Construct high-lift structural reinforced unit masonry construction by laying masonry to full height and width prior to placing of grout. Provide cleanout holes in first course of masonry, and use high-pressure water jet stream to remove excess mortar from grout spaces, reinforcing bars and top surface of structural members which support wall. Clean grout spaces daily during construction of masonry.

d. Walls: Omit every other masonry unit in first course of one wythe to provide cleanout holes. Tie wythes together with metal ties as shown or required by governing code, but provide not less than 9-gage wire ties spaced not less than 24-inches on centers horizontally and 16-inches on centers vertically for running pattern bond or 12-inches on centers vertically for stack bond.

e. Columns, Piers and Pilasters: Omit every other masonry unit around perimeter of member to provide cleanout holes. Provide reinforcing bands placed in bed joints as the structural reinforced unit masonry construction progresses. Provide bands of the size and vertical spacing shown, or as required by governing code, but not less than 9-gage wire spaced 12-inches on centers vertically.

f. Preparation of Grout Spaces: Prior to grouting, inspect and clean grout spaces. Remove dirt, dust, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcing and adjust to proper positioning. Clean top surface of structural members supporting masonry to ensure bond. After cleaning and inspection, close cleanout
holes with matching masonry units and brace closures to resist grout pressures.

g. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure, but not less than three days curing time. Install shores and bracing, if required, before starting grouting operations.

h. Place grout by pumping into grout spaces, unless alternate methods are acceptable to ENGINEER.

i. Use course grout mix. Rod or vibrate each grout lift during placing and again after excess moisture has been absorbed, but before plasticity is lost. Do not penetrate or damage grout placed in previous lifts or pours.

j. Limit grout pours to sections, which can be completed in one working day with not more than one hour interruption of pouring operation. Limit pours so as not to exceed the capacity of masonry to resist displacement or loss of mortar bond due to grout pressures.

1) Do not exceed 12 feet - 0 inches pour height.

2) Do not exceed 25 feet - 0 inches horizontal pour dimension.

k. Where pour height exceeds 4 feet - 0 inches, place grout in a series of lifts not exceeding 4 feet-0 inches height. Place each lift as a continuous pouring operation. Allow not less than 30 minutes, or more than one hour between lifts of a given pour.

l. When more than one pour is required to complete a given section of masonry, extend reinforcing beyond masonry as required for splicing. Pour grout to within 1-1/2 inches of top course of first pour. After grouted masonry is cured, remove temporary dams (if any), and lay masonry units and place reinforcing for second pour section before grouting. Repeat sequence, if more pours are required.

H. Anchoring Masonry Work:

1. Provide anchoring devices of the type specified under Section 04090, 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. Anchor masonry to cast-in-place concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips and with triangular ties fitted with flexible dovetails for anchorage to cast-in-place concrete as specified in Section 04090, Masonry Accessories.

c. Space anchors as shown, but not more than 24-inches on center vertically and 36-inches on center horizontally.
d. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, fire safing insulation, backer rod and sealant.

3. Anchor single wythe masonry veneer to backing with metal ties as follows:
   a. Anchor veneer to structural members with metal anchors embedded in masonry joints and attached to structure. Provide anchors with flexible tie section, unless otherwise shown.
   b. Anchor veneer to concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips with triangular ties, fitted with flexible dovetails for anchorage to cast-in-place concrete, snap-locked to seismic clip and attached to structural supports using anchors specified in Section 04090, Masonry Accessories.
   c. Space anchors as shown, but not more than 24-inches on center vertically and 36-inches on center horizontally.

I. 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 07920, Calking and Sealants.
   2. Provide masonry control joints items specified under Section 04090, Masonry Accessories, where masonry control joints are shown.
      a. Build in compressible fillers as specified. Install in accordance with manufacturer's written instructions.
      b. Build in factory-premolded control joint strips into masonry. Build in sash block and premolded control joint strips as the Work progresses.
      c. 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.

J. Lintels and Bond Beams:
   1. 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.
   2. Provide minimum bearing at each jamb, of 4-inches for openings less than 6 feet - 0 inches wide, and 8-inches for wider openings.
   3. On concrete and clay 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.

K. Flashing of Masonry Work:
   1. Provide concealed flashings in masonry Work as shown. Refer to Section 07620, Flashing and Trim, for type of flashing required. Prepare
masonry surfaces smooth and free from projections, which might puncture flashing. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Terminate flashing 1/2-inch from face of wall, unless otherwise shown.

a. Extend flashings beyond edge of lintels and sills at least 4-inches and turn up edge on sides to form pan to direct moisture to exterior.

b. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1-1/2 inches and seal lap with elastic sealant.

c. For metal through-wall flashing, weld joints watertight.

d. Install flashings in accordance with manufacturer's instructions and approved Shop Drawings.

e. Install elastic flashings in accordance with manufacturer's instructions and approved Shop Drawings.

2. Provide weep holes in the head joints of the first course of masonry immediately above concealed flashings. Space 24-inches on center, unless otherwise shown.

3. Install reglets and nailers for flashing and other related work where shown to be built into unit masonry construction.

4. Install elastic masonry flashing into cast-in-place elastic masonry flashing reglets with lead wedges and fill reglet with elastic flashing manufacturer's recommended bonding rubber-based adhesive cement.

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, Unglazed 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 scrapers. 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. Water Repellent Treatment: Refer to Section 07191, Liquid Water Repellent.

D. Protection:
   1. Protect the unit masonry construction from deterioration, discoloration or damage during subsequent construction operations. Refer to Section 06100, Rough Carpentry.

++ END OF SECTION ++
SECTION 04220

CONCRETE MASONRY UNITS

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 load bearing units.
      b. Integral waterproofing admixtures, 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 C90 Climatic Map establishing criteria for percent annual mean relative humidity.

B. Requirements of Regulatory Agencies: Wherever a fire-resistance classification is shown for Concrete Masonry Units construction (4-hour, 3-hour and similar designations), provide products complying with the requirements established by UL and other governing authorities.

C. 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. Distortion: Plane and edges of face of individual units, as installed in the Work, from the corresponding plane surface and edges of the prefaced concrete masonry unit shall not exceed 1/16-inch.
   3. Top and Bottom Surfaces: Ground to provide finish height of 7-5/8-inches ±1/16-inch.
4. 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.

D. Codes: Comply with applicable requirements of the Phoenix Building Code for types of concrete masonry shown or specified.

E. 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 C426, 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.

F. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C33, Specification for Concrete Aggregates.
   2. ASTM C55, Specification for Concrete Brick.
   3. ASTM C62, Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).
   5. ASTM C90, Specification for Load bearing Concrete Masonry Units.
   6. ASTM C129, Specification for Nonloadbearing Concrete Masonry Units.
   7. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units.
   8. ASTM C331, Specification for Lightweight Aggregates for Concrete Masonry Units.
   9. ASTM C426, Test Method for Drying Shrinkage of Concrete Masonry Units.
   10. ASTM C744, Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
   13. UL Design Numbers U901 through U908.
1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   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: Submit for approval the following:
   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. Comply with the requirements of Section 01332, 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 ASTM C744.

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 01651, Transportation and Handling of Materials and Equipment.
   2. Provide units delivered by the manufacturer or manufacturer's agent. At time of unloading, units shall conform to the requirements prescribed in ASTM C90, 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 01661, Storage of Materials and Equipment.

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 C90, Type I, Moisture-Controlled Units


D. 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. Bullnose units for outside horizontal and vertical corners including doors, windows, louvers and other openings, unless specifically shown by note indicating that this feature is not required.
   3. Provide square edge block for horizontal and vertical outside corners, except where shown as bullnose.
   4. 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.

E. 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:
   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.

F. Weight: Provide the following:
   1. Provide medium weight units using concrete aggregates complying with ASTM C33 producing dry net weight of not less than 105 pounds per cubic foot.

G. Exposed Faces: Provide integrally colored split face units with the manufacturers' standard and custom colors as decided by the OWNER.

H. Provide two-core concrete masonry units.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 01201, Unit Masonry Construction, Section 04060, Mortar and Masonry Grout, and Section 04090, Masonry Accessories.

++ END OF SECTION ++
SECTION 05051

ANCHOR BOLTS, TOGGLE BOLTS
AND CONCRETE INSERTS

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, toggle
      bolts and concrete inserts.

B. This Section includes all anchor bolts, toggles and inserts required for the Work, but
   not specified under other Sections.

C. The types of Work using the anchor bolts, toggles and inserts include, but are not
   limited to the following:
   1. Baffles, weirs and troughs.
   2. Sprockets and conveyors.
   3. Rails.
   4. Sluice and slide gates.
   5. Hangers and brackets.
   7. Piping.
   8. Tanks.
   10. Grating and floor plate.
   11. Electrical, Plumbing and HVAC Work.
   12. Metal, wood, and plastic fabrications.
   13. Partitions and ceilings.
   14. Shelf angles and masonry lintels.
   15. Structural members and accessories.

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 A36, Specification for Carbon Structural Steel.
   2. ASTM A123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and
      Steel Products.
4. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
5. ASTM A484, Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
6. ASTM A525, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
10. ASTM F593, Stainless Steel Bolts; Hex Cap Screws, and Studs.
13. ICBO, International Conference of Building Officials.

B. Inserts shall be ICBO, UL or FM approved.


1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Setting drawings and templates for location and installation of anchorage devices.
   2. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.
   3. Copies of ICBO, UL or FM Reports certifying load carrying capacities and installation requirements for the anchorage devices.
   4. Comply with the requirements of Section 01332, Shop Drawing Procedures.

B. Samples: Submit for approval the following:
   1. Representative samples of anchor bolts, toggle bolts and concrete 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, toggle bolt, 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 for concrete.

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 ICBO Evaluation Report, or similar certifications by UL or FM, 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 4,000 psi concrete:

<table>
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<tr>
<th>Bolt Diameter (Inches)</th>
<th>Min. Shear (Pounds)</th>
<th>Min. Pull-Out Load (Pounds)</th>
</tr>
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<tr>
<td>1/2</td>
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<td>7,600</td>
</tr>
<tr>
<td>5/8</td>
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<td>11,500</td>
<td>17,000</td>
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<tr>
<td>7/8</td>
<td>15,700</td>
<td>20,400</td>
</tr>
<tr>
<td>1</td>
<td>20,500</td>
<td>28,400</td>
</tr>
</tbody>
</table>

2.2 APPLICATION

A. Where a concrete anchor is shown on the Drawings, install either an adhesive anchor or anchor bolt. In masonry, where a concrete anchor is shown on the Drawings, only anchor bolts and adhesive anchors shall be used. Comply with the requirements of Handrails and Railings.

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 on the Drawings.
   2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

E. Toggle Bolts:
   1. Use for fastening brackets and other elements onto masonry units.

2.3 MATERIALS

A. Anchor Bolts:
   1. For Anchor Bolts, see Section 03252, Anchorage in Concrete.

B. Adhesive Anchors:
   1. For Adhesive Anchors, see Section 03252, Anchorage in Concrete.

C. Concrete Inserts:
   1. For Concrete Inserts, see Section 03252, Anchorage in Concrete.

D. Toggle Bolts:
   1. Provide spring-wing toggle bolts, with two-piece wings.
   3. Product and Manufacturer: Provide toggle bolts by one of the following:
      a. The Rawlplug Company, Incorporated.
      b. Haydon Bolts, Incorporated.
      c. Or equal.

E. Powder activated fasteners and other types of bolts and fasteners not specified herein shall not be used, unless approved by ENGINEER.

F. Expansion anchors will not be allowed.
PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which anchor bolts, toggle bolts, 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. Use toggle bolts for fastening brackets and other elements onto masonry units.

D. 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 adhesive anchor or reinforcing bar. Properly clean out the hole utilizing a wire brush and compressed air to remove all loose material from the hole, prior to installing adhesive capsules or material.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Employ the services of 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. Responsibility for the failure of any adhesive anchors or reinforcing bars will belong to the CONTRACTOR. Should any adhesive anchors or reinforcing bars fail, all costs involved in testing the remaining 90 percent belongs to the CONTRACTOR.

C. 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.
D. Pay for all corrections and subsequent tests required to confirm the integrity of the adhesive anchor or bar.

E. The independent testing and inspection agency shall complete a report on each area. The report should summarize the observations made by the inspector and be submitted to ENGINEER.

F. 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 ++
SECTION 05120

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. ASTM A36, Specification for Carbon Structural Steel.
   3. ASTM A307, Specification for Carbon Steel Bolts and Stubs, 60,000 psi Tensile Strength.
   4. ASTM A325, Specification for High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
   5. ASTM A490, Specification for Heat-Treated Steel Structural Bolts.
   6. AWS D1.1, Structural Welding Code.
   8. AISC, Manual of Steel Construction.
   10. AISC, Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings and including the Commentary and Supplements thereto as issued.
11. AISC, Specifications for Structural Joints using ASTM A325 or 490 Bolts, approved by the Research Council on Riveted and Bolted Structural Joints (RCRBSJ) of the Engineering Foundation.

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: Submit for approval the following:
   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 09900, 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 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

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 01661, Storage of Materials and Equipment.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Rolled Steel Plates, Shapes and Bars: ASTM A36, except where other type steel is shown on the Drawings.

B. Headed Stud Type Shear Connectors: ASTM A108, Grades 1010-1020, with dimensions complying with AISC Specifications, or equal.

   1. Provide hexagonal heads and nuts for all connections.

D. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
   1. Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325 or;
   2. Quenched and tempered alloy steel bolts, nuts and washers, complying with ASTM A490.


F. 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 09900, Painting.

G. Refer to and comply with the requirements of Section 03600, Grout, Section 05210, Steel Joists, and Section 05311, Metal Roof Decking.

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 05501, 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. Wherever reaction values of a beam are not shown on the Drawings, the connections shall be designed to support the total uniform load capacity tabulated in the AISC tables for allowable loads on beams for the given shape, span, and steel specified for the beam in question.
      c. 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.
      d. 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. 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 AISC "Specifications for Structural Joints using ASTM A325 or A 490 Bolts" (RCRBSJ).
      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.
   5. Where rigid connections are required by the stresses shown on the Drawings, web shear reinforcement and stiffeners in accordance with AISC Specifications shall be provided.

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. Columns: Column shafts shall have "finished" bearing surfaces at the base and at all splice lines.

E. Structural Tubing: Structural tubing 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. 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.
C. 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.

D. 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 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts, of these Specifications for anchor bolt installation requirements.

E. 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 03600, Grout. 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.

F. 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.

G. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.
   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.

I. 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.

J. Touch-Up Painting:
   1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 09900, Painting.
   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 09900, Painting.

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 05311

METAL ROOF DECKING

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 09900, Painting.

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, Specification for the Design of Cold-Formed Steel Structural Members.
   2. AWS D1.1, Structural Welding Code.
   5. ASTM A653, Specification for Steel Sheet, Zinc-Coated or Zinc-Iron Alloy – 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.

C. Uplift Loading: Install and anchor roof deck units to resist gross uplift loading of 45 pounds per square foot at eave overhang and 30 pounds per square foot for other roof areas.

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, monorails, hangers or any other items effecting 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 A446, Grade C. Before forming, the steel shall receive a protective metal coating of zinc conforming to ASTM A653, with a minimum of 0.5-ounce zinc per square foot. The decking shall be 20-gauge, unless otherwise shown on the Drawings.

B. Decking, where shown on the Drawings, shall have sheet lengths that cover three or more spans wherever practicable.

C. Accessories shall be formed of the same material as used for the steel deck. Deck units receiving concrete fill shall be formed with integral locking lugs or embossments to provide a mechanical lock between the steel deck and the concrete.

D. Miscellaneous Steel Shapes: ASTM A36.

E. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Military Specifications MIL-P-21035.

F. Flexible Closure Strips for Deck: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.

G. 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. Dimensions: 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. Roof Sump Pans:
   1. Fabricate from a single piece of not less than 14 gage galvanized sheet steel of the same quality as the deck units; with level bottoms and sloping sides to direct water flow to the drain, unless otherwise shown on the Drawings. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 3-inches wide. Recess pans not less than 1-1/2 inch below the roof deck surface, unless otherwise shown on the Drawings or required by deck configuration. Holes for drains will be cut in the field.

D. 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.

E. Ridge and Valley Plates:
   1. Fabricate ridge and valley plates of galvanized sheet steel of the same quality as the deck units; each leg not less than 2-1/4 inches wide, bent to provide tight-fitting closure with deck units. Provide plates in ten-foot lengths, where possible.

F. 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, and preclude the possibility of the dripping of any cement paste from the concrete placed on it. 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 the 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, in order to contain concrete fill. Flashing shall be detailed and installed to prevent concrete leakage.

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. Where suspended ceilings occur, appropriate hanger supports shall be provided; coordinate with ceiling system manufacturer and installer.

Q. After erection, all damaged surfaces shall be primed with a zinc dust type primer paint.

R. 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.

S. 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. 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. Roof Sump Pans:
   1. Place roof sump pans over openings provided in the roof decking and weld to the top decking surface. Space welds not more than 12-inches on center with at least one weld at each corner. Cut opening in the bottom of the roof sump to accommodate the drain size shown on the Drawings.

G. 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.

H. Ridge and Valley Plates:
   1. Weld ridge and valley plates to the top surface of the roof decking. Lap end joints not less than 3-inches, with laps made in the direction of water flow.

I. 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.

J. 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.

K. Touch-Up Painting:
   1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 09900, Painting.
   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 09900, Painting.
   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 ++
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. Loose steel lintels.
   4. Shelf angles.
   5. Extruded aluminum stair nosings.
   6. Wheel guards.
   7. 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 A36, Specification for Carbon Structural Steel.
   2. ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel
      Hardware.
   3. ASTM A240, Specification for Heat-Resisting Chromium and Chromium-
      Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   4. ASTM A320, Specification for Alloy Steel Bolting Material for Low
      Temperature Service.
   5. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and
      Plate.
   6. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bars, Rods and
      Wire.
   7. ASTM B221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire,
      Shapes and Tubes.
8. ANSI A14.3, Safety Requirements for Fixed Ladders.
10. NAAMM, Metal Finishes Manual.
11. OSHA.

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: Submit for approval the following:
   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 01333, Samples.

B. Shop Drawings: Submit for approval the following:
   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 01330, Submittals and Section 16050, General Provisions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A36.
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 B221.
   4. Bars, Rods and Wire: ASTM B211.

C. Stainless Steel Plates and Sheets: ASTM A240, 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 A320.

E. Zinc Coated Hardware: ASTM A153.

F. Surface Preparation and Shop Priming: Refer to Section 09900, Painting. All steel shall be primed in the shop. Surface preparation and shop priming requirements are included herein, but are specified in Section 09900.

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. Loose Steel Lintels:
   1. Provide loose structural steel lintels for openings and recesses in masonry walls and partitions as shown on the Drawings. Weld adjoining members together to form a single unit where shown on the Drawings. Provide not less than 8-inches bearing at each side of openings, unless otherwise shown on the Drawings.
      a. Galvanize loose steel lintels to be installed in exterior walls.

D. 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.

E. Extruded Aluminum Stair Nosings:
   1. Fabricate of sizes and configurations as shown on the Drawings.
      a. Unless otherwise shown on the Drawings, provide ribbed abrasive filled type, using black abrasive filler.
   2. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with the manufacturer.
   3. Product and Manufacturer: Provide stair nosings by one of the following:
      b. Wooster Products Incorporated.
      c. Or equal.

F. Wheel Guards:
   1. Provide wheel guards of the bolted type, 3/4-inch thick minimum of hollow core gray iron casting, and of size and shape as shown on the Drawings. Provide holes for countersunk anchor bolts and grouting.
   2. Anchor wheel guards to concrete or masonry construction in compliance with the manufacturer's instructions. Fill cores solidly, using grout as specified in Section 03600, Grout.
   3. Wheel guards of the armored concrete type will not be permitted.
4. **Product and Manufacturer:** Provide wheel guards by one of the following:
   b. Flockhart Foundry Company.
   c. Or equal.

**G. 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:
      b. Or equal.

**H. Bollards:** Provide 8-inch diameter, Schedule 40 black steel pipe, 4-feet-0-inches above grade, 4-feet-0-inches below grade. Fill with concrete and mound top. Bollards shall be primed in the shop. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

**I. 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.

**J. 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.

**K. 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 09900, Painting.

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 09900, Painting.

++ END OF SECTION ++
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 railing systems. The Work also includes:
      a. Providing openings in, and attachments to, aluminum railing systems to accommodate the Work under this and other Sections and providing for the aluminum 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 railing systems is shown on the Drawings and specified.
   3. Types of products required include the following:
      a. Top and two horizontal railing system.
      b. Toe boards.
      c. Anchors and fasteners.
      d. Sleeves, castings, reinforcing inserts, and other miscellaneous accessories.
      e. 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 railing.
   2. Coordinate all railing locations as required for Work meeting all governing authorities.

1.2 SYSTEM DESCRIPTION

A. Aluminum removable 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 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 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 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 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 Railings Systems Plumb Criteria:
   a. Limit variation of completed railing system alignment to 1/4 inch in 12 feet - 0 inch with posts set plumb to within 1/16-inch in 3 foot - 0 inch.
   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 inch.

3. Provide "pencil-line" thin butt joints.

E. Source Quality Control:

1. Obtain all 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.

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.

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. Samples: Submit for approval the following:
   1. Full size sample, 2 foot - 0 inch long, of assembled railing system at post and rail intersections with all associated components including typical mechanical and adhesively fastened connections, mounted toeboard and sleeve, all with specified controlled uniform metal finish.
   2. Samples will be reviewed for finish, color, joinery tolerances, workmanship, and general component assembly only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Drawings for the fabrication and erection of 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 railing systems. Include all plans and elevations identifying the location of all railing systems, and details of sections and connections. Show all anchorage items.
   2. Profiles of 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 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.

C. Certification: Submit for approval the following:
   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 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.


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. 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 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 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 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. 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 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 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 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. Concentrated 200-pound load and uniform force conditions shall not be applied simultaneously.
      d. Other pertinent requirements ceded to ICC/ANSI 117.1, Accessible Building and Facilities, by the City of Phoenix Building Code.
      e. 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.
      f. 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 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.
      g. Load test completed 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 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 degrees Fahrenheit to -20 degrees Fahrenheit without warp or bow of system components. Distance between expansion joints shall be based on providing a 1/4-inch wide joint at 70 degrees Fahrenheit, which accommodates a movement of 150 percent of the calculated amount of movement for the specified temperature range.

4. Provide expansion joints in railing systems where systems cross expansion joints in structure.

5. Provide railing systems as shown on the Drawings. Where 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 and railing systems of the type specified herein shall be provided.

6. Configuration of all 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 between each hatch.

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 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 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 B221, Alloy 6063-T52.

B. Aluminum Forgings: ASTM B247.

C. Extruded or Drawn Aluminum Pipe and Tube:
   1. ASTM B429 or ASTM B241, 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 inches 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 Anchors: As specified in Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
   4. Bolting Materials: As specified in Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

G. Castings:
   1. Provide high strength aluminum alloy brackets, flanges and fittings suitable for anodizing as specified.

H. Connector Sleeves: Schedule 40, 5 inches long by 1.610 inches diameter.

I. Brackets and Flanges: Provide manufacturers complete selection of standard and custom brackets and flanges for railing system posts.
J. System Components and Miscellaneous Accessories: Provide a complete selection of manufacturer's standard and custom aluminum railing systems components and miscellaneous accessories as may be required based on conditions and requirements shown on the Drawings. Show the type and location of all such items on Shop Drawings.

K. Adhesive: Two part waterproof epoxy-type as recommended by railing systems manufacturer.

L. Non-Shrink, Non-Metallic Grout:
   1. Pre-mixed non-staining cementitious grout requiring only the addition of water.
   2. Product and Manufacturer: Provide one of the following:
      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 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. Remove burrs from all exposed edges.

E. Locate intermediate rails equally spaced between top rail and finished floor.

F. Close aluminum pipe ends by using prefabricated fittings.

G. 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 railing systems posts.
   3. Provide pressure relief holes at closed ends of railing systems.
H. 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.

I. 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.

J. Mechanically Fitted Component Pipe Railing:
1. Use a non-welded pipe railing system with posts, top and intermediate rail(s), and flush joints.
2. Provide a top and two 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: Provide one of the following:
   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.
B. 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.

C. 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 degrees Fahrenheit with 12 amperes per square foot of direct current for minimum of sixty minutes.
   2. Physical Properties:
      a. Anodic Coating Thickness, ASTM B244: Minimum of 0.7 mils thick.
      b. Anodic Coating Weight, ASTM B137: Minimum of 32 mg/sq. in.
      c. Resistance to Staining, ASTM B136: No stain after five minutes dye solution exposure.
      d. Salt Spray, ASTM B117: 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. Manufacturer: Provide one of the following:
      a. Aluminum Company of America, Incorporated.
      b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the aluminum 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 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. 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. Securely fasten toeboards in place with not more than 1/4-inch clearance above floor level.
8. 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.

C. Fastening to Existing Construction:
1. Provide heavy duty floor flange and anchorage devices and fasteners where necessary for securing 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 railing systems manufacturer and as shown on approved Shop Drawings.
D. 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.

E. 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 09900, Painting.
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 railing systems of every substance after completion of installation. Comply with recommendations of both the railing, and finish manufacturer. Do not use abrasives or non-approved solvent cleaners. Test cleaning techniques on an unused section of railing before employing cleaning technique.
1. Remove all stains, dirt, grease or other substances by washing 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 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 ++
SECTION 07191

LIQUID WATER REPELLENT

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 apply all liquid water repellent.
   2. Extent of surface-applied liquid water repellent includes all exterior split-face concrete unit masonry.
   3. Types of liquid water repellent required include the following:
      a. Liquid, colorless and non-gloss producing, VOC-compliant, water repellent coating.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: The applicator must be acceptable to the manufacturer and regularly engaged in this type of Work.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's certification indicating liquid water repellent coating conforms to or exceeds requirements stated herein.
   2. Include detailed chemical analysis and test results of material applied to surfaces similar to requirements of this Section.
   3. Manufacturer's instructions for methods and application procedures.

B. Job Mock-Up:
   1. Apply coating to sample test area on job mock-up specified in Section 04220, Concrete Masonry Units, to illustrate color change and surface sheen.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's instructions for storage, shelf life, and handling.

B. Comply with paragraph 1.2.B of Specifications Section 01413, Contractors Hazardous Materials Management Program.
1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not apply coating in ambient temperatures lower than 50°F.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chemical Bonding Coatings without Silicone Resin: Provide organosilane solution diffused quartz carbide type, or acrylic modified stearate; colorless, non-gloss producing and VOC compliant.

B. Product and Manufacturer: Provide one of the following:
   2. Series 663, Prime-a-Pell NS by Chemprobe Coating Systems, Tnemec Company, Inc.
   3. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that surfaces to receive water repellent coatings are clean, free of efflorescence, stains, oil, grease, or other foreign matter detrimental to application.

B. Verify sealants have been installed in areas to receive coatings.

3.2 PREPARATION

A. Remove loose particles and foreign matter. Remove grease or oil with a solvent, effective alkaline cleaner, or detergent as instructed by coating manufacturer. Scrub surfaces with water.

B. Allow surfaces to dry prior to application.

3.3 PROTECTION OF ADJACENT SURFACES

A. Protect adjacent surfaces which are not scheduled to receive liquid water repellent coatings. If applied or splashed onto surfaces not specified to receive liquid water repellent, remove immediately, using manufacturer approved method. Keep cleaning materials available for immediate use.
3.4 APPLICATION

A. Apply coating in accordance with manufacturer's instructions and recommendations.

B. Apply in two continuous, uniform coats as recommended by manufacturer. Allow to dry between coats as recommended by the manufacturer.

C. Protect materials in vicinity of application. Do not apply coating by spray on windy days. Protect shrubs, plants, trees, bushes and vehicles etc., from possible over spray. Remove any over spray coating immediately.

++ END OF SECTION ++
SECTION 07220

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. 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. Submit proof of acceptability of installer by manufacturer to ENGINEER.

B. Source Quality Control:
   1. Obtain extruded polyisocyanurate 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 2012 Phoenix Building Construction Code, and comply with the following roof insulation requirements:
   1. Underwriters Laboratories requirements for roof deck constructions which are rated "UL Class A".

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   3. ASTM C203, Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
   5. ASTM C303, Test Method for Density of Preformed Block-Type Thermal Insulation.
  10. ASTM D696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C.

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 01333, 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 01332, 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.
   5. All required roof insulation details approved by the roof insulation manufacturer and the manufacturer of the respective roofing systems.

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 01651, Transportation and Handling of Materials and Equipment.

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 01661, Storage of Materials, and Equipment.

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.

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.

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.
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.

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 C1289, 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 D1621: 25 psi minimum.
      b. Flame Spread, ASTM E108: Class A.
      c. Smoke Development, ASTM E84: 120 maximum.
      d. Vapor Transmission, ASTM E96: 0.8 perms/inch.
      f. Maximum Water Absorption, ASTM C209: 0.10 percent by volume.
   5. Number of Layers: As required by thickness of roof insulation shown on the Drawings.
   6. Product and Manufacturer: Provide one of the following:
      b. Or equal.

B. 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.

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 07540, Thermoplastic Polyethylene (TPO) Membrane Roofing.

B. Board-Type Roof Insulation Units: Install rigid board-type roof insulation 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 gallon 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.

3.4 PERFORMANCE

A. Roof insulation Work shall withstand the uplift forces of wind, as defined by the Roofing Guarantee. Refer to Section 07540.

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.

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.

3.7 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.
SECTION 07540

THERMOPLASTIC POLYOLEFIN (TPO) MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Fully-adhered, thermoplastic polyolefin membrane, white, scrim-reinforced roofing system.

1.2 REFERENCES

A. ASTM International (ASTM):

1.3 SYSTEM DESCRIPTION

A. Fire Hazard Classification:
   1. UL Class A.

B. Design uplift pressures:
   2. ANSI/SPRI WD-1 "Wind Design Standard Practice for Roofing Assemblies".

1.4 SUBMITTALS

A. Product data: Include specifications, outline of roof and size, deck type, location of all penetrations, and plan identifying high and low points and field verified elevations, fastener type and flashing details.

B. Samples: Membrane material, 8 inches square.

C. Manufacturer's Installation Instructions.

D. Certificates:
   1. UL Listed.
   2. Letter of certification from the manufacturer certifying the roofing contractor is authorized to install the manufacturer's roofing system, include certified foreman and training dates.
   3. Indicating membrane thickness from the membrane manufacturer.
E. Maintenance manual: Include repair instructions.

F. Warranties by installer and manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer-approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

C. Pre-installation conference: Conduct prior to beginning work. Installer, Owner, Manufacturer's Representative and Engineer shall be in attendance.

D. Verify existing roof, deck insulation, and roof specialties and accessories in Section 07220 - Roof Insulation, and Section 07710 - Roof Drainage Specialties are compatible with membrane roofing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Deliver materials with appropriate labels indicating warnings, storage conditions, lot numbers, and usage instructions.

1.7 WARRANTIES

A. Manufacturer's warranty: Minimum 20 years to correct defective roofing materials, including installation. Damage from hail up to 5 inches in diameter shall be included as part of the manufacturer's warranty.

B. Roofer's warranty: Minimum 2 years to correct defective workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURER AND TYPE

A. Type: Fully-adhered, white, reinforced thermoplastic polyolefin (TPO) membrane assemblies.

B. Manufacturers: One of the following or equal:
   2. Johns Manville, Willows, CA, JM TPO.
2.2 COMPONENTS

A. Scrim-Reinforced Thermoplastic Polyolefin (TPO) Sheet: 60 mil, scrim-reinforced, white, membrane 10 feet wide maximum by appropriate length conforming to following minimum physical properties:
   1. Tensile Strength: Minimum of 300 lbf as tested using ASTM D751.
   2. Tear strength: Minimum 45-60 pounds when tested in accordance with ASTM D751.

B. Cover board shall be provided as recommended by roofing manufacturer, and as required by the warranty.

C. Flashing, bonding adhesive, sealant, primer, seam caulk, insulation replacement, and fasteners: Membrane manufacturer approved.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify the following:
   1. Maximum 1/4-inch insulation joint widths.
   2. Proper installation of nailers and cants.
   3. Dry, clean, and smooth substrate without sharp edges and debris.

3.2 INSTALLATION

A. Install roofing system in conformance with manufacturer's instructions.

B. Install perimeter sheets.

C. Lay field sheets with long edges perpendicular to roof slope, with edge of roll aligned with perimeter sheets.

D. Fully adhered membrane shall be bonded to the substrate with manufacturer's approved adhesives. Overlap fastened edges of installed membrane by approximately 5-1/2 inches at fastening plates and 2 inches at end roll sections.

E. Seal cut edges with seam caulk.

F. Fasten and finish perimeter in accordance with membrane manufacturer's standard gravel stop details. Field verify gravel stop and fascia, and aluminum coping transitions.
3.3 FIELD QUALITY CONTROL

A. Arrange for manufacturer's warranty supervision and inspection. Notify Owner and Engineer 48 hours in advance of date and time of inspection.

++ END OF SECTION ++
SECTION 07620

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. Shop-formed, snap-lock metal coping flashing and shop-formed cap flashing requiring no exposed fasteners or splice-plates.
   b. Extruded gravel stops and fascia extensions.
   c. Custom shop-fabricated metal coping and gravel stop corner and transition flashings.
   d. Miscellaneous flashing not supplied under other Sections.
   e. Complete selection of custom and premium custom-blended full-strength, polyvinylidene fluoride finishes and colors with extended life topcoat.
   f. Protective strippable film on all surfaces of snap-lock metal coping, extruded aluminum gravel stops, fascia extensions, and metal coping corner and transition flashings.
   g. 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 A480, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   2. ASTM A666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar.
   5. ASTM B101, Specification for Lead-Coated Copper Sheet and Strip for Building Construction.
15. ASTM D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
21. ASTM D3363, Test Method for Film Hardness by Pencil Test.
23. The Aluminum Association, AA, ASD-1 - Aluminum Standards and Data.

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 01332, 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 04201, Unit Masonry Construction, and Section 07540, Thermoplastic Polyolefin (TPO) 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 01651, Transportation and Handling of Materials and Equipment.

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 01661, Storage of Materials, and Equipment.

1.5 JOB CONDITIONS

A. Scheduling:
   1. Do not proceed with flashing and trim Work until curb and substrate construction, cant strips, blocking, 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 manufacturer's twenty-year warranty on the specified coil coated polyvinylidene fluoride based coating.

B. 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.

C. 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.

D. 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.

E. 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. Comply with fabrication details recommended by 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:

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:
      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. Miscellaneous Materials:
   1. Nails, Screws and Rivets: Same material as flashing sheet, or as recommended by manufacturer of flashing sheet.
   2. Cleats: Same metal and gage as sheet being anchored, 2-inches wide, punched for two anchors.
   3. Sealants: Refer to Section 07920, Calking and Sealants.

2.3 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 its 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 D4214: Chalking, not more than No. 8, after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D2244: No greater than 5 NBS units after removal of external deposits and after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D2247; no blisters after 3,000 hours.
d. Salt Spray, ASTM B117: 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 D968: Coefficient of abrasion of 67 minimum.

j. Gloss, ASTM D523: 30±5 reflectivity at 60°F.


l. Dry Film Thickness, ASTM D3363: 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 D522: No cracking prior to metal fracture.

o. Acid Resistance, ASTM D1308: 16 hour spot test with five percent hydrochloric acid - 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. Installation of Aluminum Flashing and Trim: 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.

B. 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.

C. Installation of 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.

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.

3.5 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 ++
SECTION 07710

ROOF DRAINAGE 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 gutters, and downspouts.
   b. All miscellaneous straps, fittings, and fasteners.
   c. 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 weatherproof 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, 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 0.050-inch; 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:
      b. Or equal

C. Size and Profile:
   1. Downspouts: As shown on the Drawings.
   2. Gutter: As shown on the Drawings. Length of 10 feet - 0 inch, straps at 18-inches on center.

D. 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.

E. Product and Manufacturer: Provide one of the following:
2. Or equal.

2.2 FABRICATION

A. General:
1. The fabrication requirements for gutter systems, and downspout Work apply to both shop-fabricated.
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. Support and Anchorage: Fabricate units with adequate provisions for support and anchorage, of the types required for the indicated method of installation.

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 the gutter system, 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 04201, Unit Masonry Construction, Section 07540, Thermoplastic Polyolefin (TPO) Membrane Roofing, and Section 07620, 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 09900, Painting.

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 gutter systems, and downspouts from all damage until Final Completion.

B. Gutter systems, 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 07920

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.
2. ASTM C661, Test Method for Identification Hardness of Elastomeric-Type Sealants by Means of a Durometer.

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 01333, 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:
   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 01661, Storage of Materials and Equipment.
   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 caulking and sealant installer, the caulking 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 C794 (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 C661: 15 to 50 (Shore A).
      4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
      5) Accelerated Aging, ASTM C793: 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 C794: (Minimum 5 lbs/linear inch with no adhesion failure): 28 lbs.
         3) Hardness (Standard Conditions), ASTM C661: 15 to 50 (Shore A).
         4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
         5) Accelerated Aging, ASTM C793: 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.
         3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
         4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
         5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
      b. Product and Manufacturer: Provide one of the following:
         1) SL2 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 caulking and sealant manufacturer.

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.

++ END OF SECTION ++
SECTION 08105

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. Seamless, galvanized steel, paper honeycomb core, internally-reinforced, flush doors.
      b. Fully welded, galvanized steel, internally-reinforced, door frames.
      c. 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. Source Quality Control:
   1. After Shop Drawing approval, manufacturer shall not make any further detailing, fabrication or changes to approved methods of support and anchorage, nor shall doors and frames be brought to the site which do not conform in all ways to performance criteria specified.
   2. Prepare a written report on the testing of up to one hollow metal flush doors and frames, selected at random by ENGINEER from those brought to the site, for the purpose of verifying, by independent laboratory analysis, the provision of all features specified and indicated on approved Shop Drawings, at no additional cost to OWNER. Any door and frame found failing to comply with specified features shall be cause for ENGINEER to require complete removal of all doors and frames from the site, and the provision of new units complying with Specifications, as confirmed by independent laboratory testing, at no additional cost to OWNER.
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.
   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.

D. Codes: Comply with applicable requirements of the 2012 Phoenix Building Construction 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.
   4. ANSI A250.4, Test Procedures and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.
   7. ANSI in association with Steel Door Institute, ANSI/SDI 100, Steel Doors and Frames.
  10. ASTM A653, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by The Hot-Dip Process.
  14. Steel Door Institute, SDI 105, Recommended Erection Instructions for Steel Frames.
  15. Steel Door Institute, SDI 106, Recommended Standard Door Type Nomenclature.
17. Steel Door Institute, SDI 117, Manufacturing Tolerances Standard Steel Doors and Frames.
20. SSPC-Paint 2, Cold Phosphate Surface Treatment.
21. SSPC-Paint 27, Basic Zinc Chromate-Vinyl Butyral Wash Primer.
23. Door and Hardware Institute, DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.

1.3 SUBMITTALS

A. Samples: 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 01333, Samples.
   2. 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.
   3. ENGINEER reserves the right to require samples showing fabrication techniques and workmanships of all component parts, and the detailing and fabrication of accessories and auxiliary items for all door and frame Work, before fabrication of the Work proceeds.

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 08710, Finish Hardware.
   2. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown on the Drawings.

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.
3. Refer to and comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

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. Refer to and comply with the requirements of Section 01661, Storage of 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

A. Submit for approval copies of written guarantee signed by the manufacturer, installer, and CONTRACTOR, agreeing to replace metal doors and frames which fail in materials or workmanship within three years of the date of Final Acceptance. Failure of materials or workmanship shall include (but not be limited to) failures in operation of doors and hardware, excessive leakage or air infiltration, excessive deflections, delamination of panels, deterioration of finish or metal in excess of normal weathering, and defects in accessories, weather-stripping, and other components of the Work.

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. Grade III, Extra Heavy-Duty, 1-3/4-inches thick (Level A); Model 2A, seamless design.

B. Door and Panel Construction:
   1. Provide doors of two outer stretcher-leveled sheets, 18-gauge minimum. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or edges, 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.
   3. All building exterior man doors shall be of a minimum four-hinge type.

C. Frame Construction:
   1. Form frames of cold-rolled sheet material, 14-gauge 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.
2.2 MANUFACTURERS

A. Product and Manufacturer: Provide one of the following:
   2. Or equal.

2.3 MATERIALS


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 A153, 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.
   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 A153, Class C or D as applicable.

E. Miscellaneous Accessories:
   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. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
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 joints continuously, grind, dress, and make smooth, flush, and invisible. Filler to conceal manufacturing defects shall not be acceptable.
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. 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 spreader bar; except provide drywall frames as specified.
3. Grind all exposed welds flush and smooth.
4. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at the top so they can be filled with grout.
5. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
6. Head Anchors: Provide two anchors at head of frames exceeding 3 foot-6 inches wide for frames mounted in drywall partitions.

7. 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.

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 08710, Finish 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: 3/16-inch 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, 3/16-inch 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. 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. Refer to Section 08800, Glass, Plastic and Glazing.

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. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT 2), or basic zinc chromate-vinyl butyral solution (SSPC-PT 27).
D. Refer to Section 09900, Painting, for field-applied primer and finish paint for exterior or interior exposed ferrous, non-ferrous, or galvanized surfaces.

E. 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.

F. 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 B117 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-inch 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 spreaders leaving surfaces smooth and undamaged. Remove spreader bars only after frames have been properly set and secured.
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 04201, Unit Masonry Construction.
   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 inch 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 inch 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:
      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 08710, Finish 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 ENGINEER, 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 ++
SECTION 08710

FINISH 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 door frame.
   3. Types of products required:
      a. Mortise Hinges.
      c. Overhead Surface-Mounted Door Closers.
      d. Heavy-Duty, Concealed Overhead Holders and stops.
      e. Stripping and Seals.
      f. Thresholds.
      g. 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 2012 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.
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.
7. ANSI in association with Builders Hardware Manufacturers Association, ANSI/BHMA A156.8, Door Controls - Overhead Stops and Holders.
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.
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.

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.


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 01651, Transportation and Handling of Materials and Equipment.
   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 01661, Storage of Materials and Equipment.

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 4-1/2-inch standard weight (0.134-inch).
      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.
   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.
C. 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.
      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-inch 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.
   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:
      b. Schlage Manufacturing Company; an Allegion PLC Company L-Series Mortise Lock, 17 Lever, B-rose with 64-42x26Dx106 L Cam.

D. 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.
E. 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 leaves 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.
   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.
  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.
  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.
F. 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.
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.

G. 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.
   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.

H. 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.
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:
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.

I. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2
   (non-sag) Class A for use with thresholds.

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 08105, Hollow Metal Doors and Frames.

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:

OFFICE/RESTROOM BUILDING:
DOOR NUMBER(S): 101-1
1. MORTISE HINGES
2. HIGH-SECURITY MORTISE LOCKS AND LATCH SETS (05)
3. CYLINDERS
4. OVERHEAD, SURFACE MOUNTED, DOOR CLOSERS
5. HEAVY-DUTY, CONCEALED OVERHEAD HOLDERS AND Stops
6. STRIPPING AND SEALS
7. THRESHOLDS

OFFICE/RESTROOM BUILDING:
DOOR NUMBER(S): 102-1
1. MORTISE HINGES
2. HIGH-SECURITY MORTISE LOCKS AND LATCH SETS (F19)
3. CYLINDERS
4. OVERHEAD, SURFACE MOUNTED, DOOR CLOSERS
5. SILENCERS

++ END OF SECTION ++
SECTION 08800
GLASS, PLASTIC AND GLAZING

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 glass, plastic and glazing Work.
   2. Extent of glass, plastic, and glazing is shown on the Drawings.
   3. Types of products required include the following:
      a. Clear insulated laminated glass.
      b. Structural and non-structural glazing sealants.
      c. Miscellaneous glazing materials.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the glass, plastic and glazing Work.
   2. Review products specified under other Sections and coordinate the selection of those items to match the Work of this Section.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: The installer of the glass, plastic and glazing materials shall be a firm with documented skill and successful experience in the application of the types of glass, plastic and glazing required and who agrees to employ only tradesmen trained, skilled and with successful experience in installing the types of glass and glazing systems specified and who are certified under the National Glass Association Glazier Certification Program as Level 3 (Master Glaziers). Submit records of experience and certification to ENGINEER.

B. Manufacturer Qualifications:
   1. The manufacturer of the glass, plastic and glazing materials shall be a firm with documented successful experience in manufacturing the types of glass, plastic and glazing specified.
   2. Obtain all glass, plastic and glazing from manufacturer-approved fabricators. Submit verification of acceptability to ENGINEER.
   3. Obtain glass, plastic and glazing materials from manufacturers who will send a qualified Technical Representative to project site, for the purpose of advising the installer of proper procedures and precautions for the use of the materials.
C. **Performance Criteria:** For glass and plastic performance, manufacture, size, type, construction, and thickness comply with the following:

1. Provide glass, plastic and glazing systems capable of withstanding normal thermal movement and wind and impact loads without failure, including loss or glass breakage attributable to defective manufacturer, fabrication, and installation; failure of sealants (both structural and weather-resisting) to remain watertight, airtight and to maintain structural performance characteristics specified; deterioration of glazing materials; or other defects in construction.


4. **Fabricating and Detailing Criteria:** Provide structural analysis calculations and details indicating compliance with the following minimum fabricating and detailing criteria for fabricating and detailing all glass shown:
   
   
   b. Importance Factor: Category 1; \( I_w = 1.15 \); Design Factor: 1.15.
   
   c. Exposure Category: Exposure C; \( C_e = 1.13 \).
   
   d. Wind Stagnation Pressure: \( q_s = 12.6 \) psf.
   
   e. Load Duration: 60 seconds or less.
   
   f. Probability of Breakage for Vertical Glazing: Eight lites per 1000 under wind action.

5. Glass and plastic manufacturer's recommended load tables and as shown on the Drawings. Where load tables indicate acceptability of lesser thickness material or alternative features then specified, provide specified thicknesses and features as a minimum. Where load tables indicate the need for greater thickness than those specified, provide greater thickness at no additional cost to the OWNER. Comply with practice for determining minimum thickness and types of glass required to resist governing code required loading according to ASTM E1300.

6. Verify age of all structural silicone used for window wall glazing. Test sealant in accordance with sealant manufacturer's recommendations, if questions of acceptability for project use are indicated by sealant manufacturer's recommendations and product limitations.


8. Provide dimensions and detail drawings of structural silicone glazing manufacturer's recommended glue line thickness and bite dimensions, and include these on Shop Drawings submitted to ENGINEER. Verify that these details have been reviewed by a Technical Representative of the structural silicone manufacturer and window wall system manufacturer and are in compliance with governing regulations.
D. Requirements of Regulatory Agencies:
   1. Safety Glass: Comply with ANSI Z97.1, with label on each piece of glass, as required.

E. Allowable Tolerances: Provide heat-strengthened and tempered glass compliance in with ASTM C1048. Provide tongless temper glass by manufacturer's special process which will ensure the strictest possible tolerance; glass shall not exceed the following flatness tolerances (either face, any direction, any location except for 2-inch wide border area) based on 1/4-inch glass thickness with inversely proportionate tolerances of other thicknesses:
   1. For 3-foot run: 1/8-inch bow.
   2. For 7-foot run: 1/4-inch bow.
   3. For 10-foot run: 3/8-inch bow.

F. Source Quality Control:
   1. To the greatest extent possible, provide each type of glass, plastic and glazing materials from one manufacturer.
   2. All sealant system and sealant system components for all polycarbonate products shall be approved for use by polycarbonate plastic manufacturer. Approvals shall accompany Shop Drawings for plastic.
   3. Providing insulating glass with a certified Class A rating according to SIGMA.
   4. Provide insulating glass secondary sealant system compatible with structural silicone glazing system, and in compliance with ASTM E774.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   4. ASTM C1036, Specification for Flat Glass.
   5. ASTM C1048, Specification for Heat-Treated Flat Glass-Kinds HS, Kind FT Coated and Uncoated Glass.
   7. ASTM C1172, Specification for Laminated Architectural Flat Glass.
12. ASTM D635, Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supported Plastics in a Horizontal Position.
15. ASTM D2240, Test Method for Rubber Property-Durometer Hardness.
16. ASTM E774, Specification for Classification of the Durability of Sealed Insulating Glass Units.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. 12-inch square samples of each type of glass, plastic and glazing materials specified. Refer to and comply with the requirements of Section 01333, Samples.
   2. Insulating glass samples shall not be hermetically sealed and shall expose edge construction and wavelength-selective films must be included. Include specially prepared samples with each interlayer film product's identify marked on film and incorporated into sample.
   3. ENGINEER'S review will be for color and general appearance only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, and installation instructions for each type of glass, glazing sealant or compound, gasket and associated miscellaneous material required. Refer to and comply with the requirements of Section 01332, Shop Drawing Procedures.
   2. Manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the applications shown.
   3. Copies of manufacturers' specifications, "Spec-Data" sheets, installation instructions and all recommended installation precautions for required materials
and components which are not included in other submittals specified in other Sections of these Specifications. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.

4. Plans and elevations showing location of each type of glass specified and details of glazing system. Include manufacturer's recommendations for glazing.

C. Test Reports: Submit for approval the following:
   1. Certified laboratory test reports for required performance tests in compliance with ASTM C793.
   2. Provide polycarbonate and wavelength-selective insulating glass manufacturer's computer-aided sheet engineering analysis to determine deflection and rabbet depth for individual applications, specified loadings, performance requirements, support criteria, and other parameters in order to indicate compliance with the Specifications.
   3. Wavelength-selective polyester film manufacturer's computer performance analysis of each insulating glass configuration including argon-filled interlayers.
   4. Adhesion and compatibility test data and detailed drawings indicating structural silicone sealant performance and calculations indicating sealant joints have been detailed and fabricated in compliance with silicone sealant manufacturer's most conservative industry-accepted recommended guidelines for dissimilar metal adhesion. Performance calculations for the structural silicone joints shall be prepared, signed and stamped with the seal of a Registered Professional Engineer, licensed in the State of Arizona, and recognized as an expert in the required Work.

D. Certificate of Compliance: Submit for approval the following:
   1. Wavelength-selective glass manufacturer shall provide a letter of compliance verifying performance characteristics of each glass unit.
   2. Verification that all glass and plastic materials subject to the applicable standards of the Consumer Product Safety Council, Safety Standard for Architectural Glazing Material are in compliance. The certification shall be issued in conformance with procedures stated in the standard.

1.4 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery of Materials: Deliver glass, plastic and glazing materials with manufacturer's labels intact. Do not remove labels until glass has been installed. Keep all items free from contamination by materials capable of staining glass or damaging panels. Deliver glazing compounds and sealants in manufacturer's unopened, original, undamaged, and labeled containers. Refer to and comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.
B. Storage and Handling of Materials: Protect glass and plastic from edge damage at all times during handling, installation, and operation of the building. Refer to and comply with the requirements of Section 01661, Storage of Materials and Equipment.

1.5 JOB CONDITIONS

A. Environmental Conditions:
1. Do not proceed with installation of liquid glazing sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
2. Proceed with glazing only when forecasted weather conditions are favorable to proper cure and development of high early bond strength. Wherever channel action is affected by ambient temperature variations, install glazing sealants only when temperatures are in the middle third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation or compression, and bond stress will not be excessive at extremely low or high temperatures.
3. Coordinate Project Schedule to avoid delay of project.

1.6 GUARANTEE

A. Insulation Glass: Submit copies of written guarantee agreeing to repair or replace glass which fails to perform as specified, including failure of the hermetic seal due to faulty manufacturing, incompatibility of sealants or mishandling during installation, for a period of ten years from the date of Final Completion.

PART 2 - PRODUCTS

2.1 GLASS

A. Clear Insulated Laminated Glass: Provide the following:
1. Manufacturer's custom units consisting of two sheets of 1/2-inch thick clear laminated glass complying with ASTM C1036, ANSI Z97.1 and Consumer Products Safety Commission 16 CFR 1201, each sheet of glass composed of two plies of 1/4-inch clear heat-strengthened glass laminated together using a 0.060-inch thick polyvinylbutrate interlayer, the outer and inner sheets of glass permanently and hermetically sealed together at edges with spacers and sealant to provide a dehydrated air space 1/4-inch thick with -60°F dewpoint; fabricated to sizes and shapes shown on the Drawings.
2. Thickness: 1-1/4-inches.
3. Product and Manufacturer: Provide one of the following:
   b. Or equal.
2.2 GLAZING SEALANTS AND TAPES

A. General:

1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed to view, provide manufacturer's standard color which has the best overall performance characteristics for the application shown on the Drawings. Provide manufacturer's standard colors as shown on the Drawings or, if not shown, provide color selected by ENGINEER from manufacturer's standard colors to either blend or contrast with adjoining surfaces.

2. Hardness shown and specified is intended to indicate the general range necessary for overall performance. Consult the manufacturer's Technical Representative to determine the actual hardness recommended for the conditions of installation and use. Except as shown on the Drawings or specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75°F):
   a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 United inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
   b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 United inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
   c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.

3. Compatibility: Before purchase of the specified glazing materials, investigate compatibility with the channel surfaces, joint fillers and other materials in the glazing channel. Provide only materials and manufacturer's recommended variation of the specified materials which are known to be fully compatible with the actual installation condition, as shown by manufacturer's published data or certification.

B. Structural Silicone Sealant: Provide a one-component, self-priming, shelf-stable, neutral-cure, elastomeric adhesive specifically formulated for silicone structural glazing complying with the following as-cured physical properties, after seven days at 77°F and 50 percent relative humidity:

4. Tear Strength, die B; ASTM D624: 49 ppi.
5. Peel Strength, ASTM C794: 40 ppi.
6. Product and Manufacturer: Provide one of the following:
   a. DOW CORNING 995 Silicone Structural Adhesive by Dow Corning Corporation.
   b. Or equal.
C. Exterior One-Part Silicone Rubber Sealant:
   1. Silicone rubber-based, one-part elastomeric sealant, complying with the following:
      a. FS TT-S-001543, Type 2 (non-sag) Class A.
      b. Provide neutral curing type wherever both joint faces are metal, glass or other non-porous material.
   2. Product and Manufacturer: Provide one of the following:
      a. Silpruf with primer by General Electric Company.
      b. Or equal.

D. Preformed Butyl Rubber Glazing Sealant:
   1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, AAMA 804.1.
   2. Products and Manufacturers: Provide one of the following:
      a. PTI 303 Spacer Rod Tape by Protective Treatments, Incorporated.
      b. Or equal.

2.3 MISCELLANEOUS GLAZING MATERIALS

A. Setting Blocks: Neoprene, 70 to 90 durometer hardness, with proven compatibility with sealants used as recommended by the glass manufacturer.

B. Spacers: Neoprene, 40 to 50 durometer hardness, with proven compatibility with sealants used as recommended by the glass manufacturer.

C. Compressible Filler Rod: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, proven to be compatible with sealants used, flexible and resilient, with five to ten pounds per square inch compression strength for 25 percent deflection.

D. Cleaners, Primers, and Sealers: Type recommended by sealant, gasket and glass manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glass, plastic and glazing Work is to be performed, and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the glass, plastic
and glazing Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PERFORMANCE

A. Watertight and airtight installation of each piece of glass and plastic is required. Each installation must withstand normal temperature changes between 20°F and 120°F, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass and plastic, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the Work.

B. Glass and plastic manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass and plastic, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances not exceeding ±1/16-inch. Responsibility for correct glass size for each opening, within the tolerances and necessary dimensions established belongs to the CONTRACTOR.

3.3 INSTALLATION

A. General:
   1. Comply with combined recommendations of glass, plastic, window and sealant manufacturer and other materials used in glazing, except where more stringent requirements are shown on the Drawings or specified, and except where manufacturer's technical representatives direct otherwise.
   2. Comply with FGMA, Glazing Manual, and SIGMA recommendations except as shown on the Drawings and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass, plastic and glazing materials where options exist in governing standards.
   3. Inspect each piece of glass and plastic immediately before installation, and eliminate any which have observable edge damage or face imperfections.
   4. Unify appearance of each series of lights by setting each piece to match others with their predominant bow in the same direction convex to the exterior. Inspect each piece and set with pattern, draw, and bow oriented in the same direction as other pieces.
   5. Do not attempt to cut, seam, nip, or abrade glass on site which is tempered, heat strengthened, or coated.
   6. Refer to and comply with the requirements of the Hollow Metal Doors and Frames, Section 08120.

3.4 PREPARATION FOR GLAZING

A. Clean the glazing channel, or other framing members to receive glass and plastic immediately before glazing by mechanical abrasion to provide a minimum one mil surface profile.
B. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

C. Apply primer or sealer to joint surfaces.

D. Do not allow silicone sealants to come into contact with finished surfaces which will be exposed in the finished Work. Use sealant manufacturer's recommended solvent cleaner observing appropriate health and environmental procedures recommended by the solvent manufacturer.

3.5 GLAZING

A. Tape and Sealant Glazing:
   1. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips. Place setting blocks at quarter points. Remove paper backing from tape. Position glass and plastic on setting blocks and press against tape for full contact.
   2. Place glazing tape on free perimeter of glass and plastic. Seal butt joints of tape with joint sealant.
   3. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Caulk space above glazing tape to top of glazing stop. Tool exposed surfaces of calking compounds to provide a substantial "wash" away from the glass and plastic.
   4. Clean and trim excess glazing materials from the installation, and eliminate stains and discolorations.
   5. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead.

3.6 FIELD QUALITY CONTROL

A. Test for water leaks. Flood the joint exposure with water directed from a 3/4-inch hose held perpendicular to wall face, 2 feet-0 inch from joint, connected to a water system with thirty pounds per square inch minimum normal water pressure. Move stream of water along joint at an approximate rate of twenty feet per minute.

B. Test approximately five percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests 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.
C. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed.

D. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed by ENGINEER.

3.7 ADJUSTMENT AND CLEANING

A. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength, and surface durability.

B. The installer shall advise CONTRACTOR of procedures required for the protection of glass, plastic and glazing sealants and compounds during the construction period, so that they will be without deterioration or damage, other than normal weathering, at the time of OWNER'S acceptance.
   1. Furnish specific instructions on the precautions and provisions required to prevent glass damage resulting from the alkaline wash from concrete surfaces and similar sources of possible damage.

C. Protect glass and plastic from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass and plastic.

D. Remove and replace glass and plastic which is broken, chipped, cracked, abraded, or damaged in other ways during the construction period, including natural causes, accidents, and vandalism.

E. Maintain glass and plastic in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other Work.

F. Wash and polish glass on both faces not more than four days prior to Final Completion of the Work in each area. Comply with glass and plastic manufacturer's recommendations.

++ END OF SECTION ++
SECTION 09900

PAINTING

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 paint
b. Items furnished with such finishes as chrome plating or anodizing.
3. Concrete surfaces, 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.
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 three 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 be tan.
      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.
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 C1538/1538M, Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method).
   3. ASTM D3359, Methods for Measuring Adhesion by Tape Test. Method A.
   5. ASTM D4227, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces.
   6. ASTM D4228, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces.
   7. ASTM D4258, Practice for Surface Cleaning Concrete for Coating.
   8. ASTM D4259, Practice for Abrading Concrete.
   9. ASTM D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
  10. ASTM D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surface.
  11. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
  12. ASTM D4285, Test Method for Indicating Oil or Water in Compressed Air.
  13. ASTM D4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel. Methods B or C.
  15. ASTM D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
  18. ASTM E797/797M, Measuring Thickness by Manuel Ultrasonic Pulse-Echo Contact Method.
  19. ASTM F22, Hydrophobic Surface Films by the Water Break Test.
  20. ASTM F1869, Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
C. American National Standards Institute (ANSI)/NSF International (NSF):
   1. ANSI A13.1, Scheme for the Identification of Piping Systems.

D. NACE International (NACE):
   1. NACE SP0188, (Standard Practice Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
   2. NACE SP0892, Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service.

E. National Bureau of Standards (NBS):
   1. Certified Coating Thickness Calibration Standards.

F. National Fire Protection Association (NFPA):

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.
   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.

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:  

1.3 DEFINITIONS  
A. Specific coating terminology used in this Section shall be in accordance with the  
definitions in ASTM D16, ASTM D3960 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 "resurfac er" 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 its 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 inches 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 inches 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, VOCs 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 ENGINEER 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 ENGINEER 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 D4227 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces or ASTM D4228 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).
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.
   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.
   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 70 °F and 90 °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 CONTRACTOR'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 except 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 the CONTRACTOR.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Specification basis of design is Tnemec.

B. Approved Equals: Subject to meeting these specifications requirements and system approval the following manufacturers may be acceptable.

C. Submit system proposed as "Equal" for review and approval or revision as required by the ENGINEER:
   1. Sherwin Williams.
   2. Carboline.
   3. Ameron/PPG.

2.2 PAINTING SYSTEMS

A. New and Existing Cast-In-Place Concrete Walls: Coat per Drawings.

B. 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:
   1. 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.

C. 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.

D. 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.

E. 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, VOCs, 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 facilities 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 ClothRub 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 D4263, ASTM F1869 or ASTM F2170. 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 an 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 D4417.

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-inch 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.

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 5°F 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.
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 1 inch 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.


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 1 or 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 REPRESENTATIVE 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.
## SAMPLE DAILY LOG

<table>
<thead>
<tr>
<th>Hold Point/Inspection Item</th>
<th>Performed by Contractor's QC</th>
<th>Status</th>
<th>Action Taken to Resolve UNSAT Conditions</th>
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<tr>
<td>Adequate access &amp; lighting provided</td>
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<td>SP-1 performed and grease, oil, &amp; contamination removed</td>
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<td>UNSAT</td>
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Engineer: | GC: | Paint Contractor:  
Eng Contact: | GC Contact: | Supervisor:  
Structure Description: | Date:  
Specification: | Project:  

February 2018 09900-33 10093D11
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<tr>
<th>Hold Point/Inspection Item</th>
<th>Performed by Contractor’s QC</th>
<th>Status</th>
<th>Action Needed to Resolve UNSAT Conditions</th>
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## Coating Materials

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## Coating Material & Mixing Data

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<th>Coating Start/Stop Time</th>
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++ END OF SECTION ++
SECTION 10400

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. 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. Stainless steel fasteners, supports, very-high-bond high-performance mounting tape, primers, 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 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.

F. Codes: Comply with the 2012 Phoenix Building Construction Code.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   5. ANSI A13.1 Scheme for the Identification of Piping Systems.
11. ANSI Z535.5, Accident Prevention Tags (for Temporary Hazards).
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 01332, 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 8-1/8 inches by 11-7/8 inches by 1-5/8 inches deep. Sign housing shall consist of an AA-A42 color anodized extruded aluminum frame and legend protected by a temper-resistant polycarbonate shield. The size, graphics and background colors of the sign legend shall conform to all relevant code requirements.

B. Lumination for exit signs shall be provided by sealed, replaceable phos-phor-coated tubes containing tritium located directly behind each portion of each letter providing 0.13 to 0.16 foot-lamberts of illumination at time of manufacturer. The tritium light sources shall be housed in a single impact-resistant module.

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:
   2. Or equal.
2.2 INFORMATION 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-inch 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:
   2. Or equal.

2.3 HEALTH, SAFETY, WARNING, FLOOR LOADING AND FIRE EXTINGUISHER LOCATION SIGNS

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Size and Thickness: 0.125-inch 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:
   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

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe or Covering*</th>
<th>Size of Legend Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4-inches to 1-1/4 inches</td>
<td>1/2-inches</td>
</tr>
<tr>
<td>1-1/2-inches to 1-7/8-inches</td>
<td>3/4-inches</td>
</tr>
<tr>
<td>2-inches to 5-7/8-inches</td>
<td>1-1/4-inches</td>
</tr>
<tr>
<td>6-inches to 9-7/8-inches</td>
<td>2-1/2-inches</td>
</tr>
<tr>
<td>10-inches and Over</td>
<td>3-1/2-inches</td>
</tr>
</tbody>
</table>

*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-inch.
   b. Clamps: Brass.
   c. Lead Seals: Monel; 4 ply, 0.014-inch 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 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.

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

2.9 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.
   5. Color: Dark grey.
   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.


2.10 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. 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, flow check, 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 10522

PORTABLE FIRE PROTECTION EQUIPMENT

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 10400, Identification Devices.

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 inch. 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 10732

SHADE FABRIC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Fabricate, and install shade fabric on the structure as detailed including:
   1. Fabricated shade panels.
   2. Stainless steel cables.
   3. Clamping.
   4. Fasteners.

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.

1.2 REFERENCES

A. ASTM International (ASTM).

1.3 SYSTEM DESCRIPTION

A. The shade shall be designed as specified on the drawings.

B. Shade fabric shall be flame-resistant.

C. Life safety:
   1. All fabric shade structures shall be designed so no life safety issue is created in the event of a loss of a part of the fabric.
1.4 QUALITY ASSURANCE

A. Fabrication and erection is limited to firms with proven experience in design and construction of fabric shade structures and such firms shall meet the following minimum requirements:
   1. A single Contractor should manufacture, and erect the fabric shade.
   2. The Contractor shall demonstrate to have a minimum of 10 years experience in the engineering, fabrication, and erection of permanent fabric structures.
   3. The Contractor shall demonstrate that it has a staff of experienced fabric structure installation personnel who will undertake the installation of each project.

1.5 WARRANTY

A. After final payment, the Contractor shall furnish the Owner with a written 10-year warranty, which warrants that the fabric panels (cloth, stitching, and fading), its perimeter attachment system, and the structural support systems supplied and installed by the subcontractor has been installed in accordance with the project and manufacturer's specifications and will be free from defects in materials and workmanship which will impair its normal use or service.
   1. The warranty shall extend from the date of substantial completion of the fabric panel shade structure, specifically the first date on which the entire fabric panel system is subject to design pre-stress conditions.

1.6 SUBMITTALS

A. Contractor shall submit drawings and calculations showing the design meets all code provisions.

B. Calculations shall include the fabric attachment and tensioning.

PART 2 - PRODUCTS

2.1 MANUFACTURER/FABRICATORS

A. The following or equal:
   1. USA SHADE & Fabric Structures, Inc.

2.2 MATERIALS

A. Erection hardware:
   1. Bolt and fastening hardware shall be determined based on calculated engineering loads.
   2. Specifications, based on the following load requirements are:
      a. Low strength: ASTM F593 stainless steel bolts, nuts, and washers.
c. High strength: ASTM A325 zinc-plated steel bolts, nuts, and washers.

B. Cable:
1. Steel cable is determined based on calculated engineering load.
   a. For light and medium loads: 1/4-inch (nominal) galvanized 7 by 19 cable is used.
   b. For heavy loads: 3/8-inch (nominal) galvanized 7 by 19 cable is used.

C. Thread:
1. Gore™ TENARA® sewing thread is made up of 100 percent expanded polytetrafluoroethylene fiber, known as Teflon®.
   a. The sewing thread carries a 10-year warranty against deterioration from exposure to the elements.
2. Shall be high strength and low shrinkage.
3. Shall have a wide temperature and humidity range.
4. Flew and abrasion resistant and ultra violet radiation immunity.
5. Shall be unaffected by cleaning agents, acid rain, mildew, rot, chlorine, saltwater, and pollution.
6. Lockstitch thread: 1200 Denier or approved equal.
7. Chainstitch thread: 2400 Denier or approved equal.

D. Edge details:
1. Perimeter shall contain cables and be double lock stitched.
   a. The cable shall be contained in a non-tear cloth edge firmly sewed to the fabric.
2. Brass grommets spaced at one foot centers shall be installed inside the cable and in the non-tear edge.

E. Fabric:
1. Raw material:
   a. Shadesure® High Density Polyethylene (or equal).
   b. Special chemicals for ultra violet stability.
2. Construction:
   a. Monofilament tape construction.
3. Fabric panel material:
   a. Cloth shall be made of Shadesure® high density polyethylene cloth with ultra violet stabilizer treatment (or equal).
   b. Color shall be as selected by Engineer.
      1) Red is not acceptable.
   c. The material shall be manufactured with tensioned fabric structures in mind.
   d. The fabric knit is to be made using monofilament and tape filler which has weight of 0.6 ounce per square foot.
      1) Material to be Rachel knitted so material will not unravel if cut.
e. Burst strength of 35 pounds per square inch.

<table>
<thead>
<tr>
<th>Finish</th>
<th>Stentored</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shade Protection</td>
<td>80 percent</td>
</tr>
<tr>
<td>UV Protection</td>
<td>90 percent</td>
</tr>
<tr>
<td>Tear Tests (lbs)</td>
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</tr>
<tr>
<td>Warp 200</td>
<td>Weft 450 pounds</td>
</tr>
<tr>
<td>Fabric Weight (oz/m2)</td>
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<tr>
<td>Life Expectancy</td>
<td>12 years in sun</td>
</tr>
<tr>
<td>Fading</td>
<td>Minimum fading after 10 years</td>
</tr>
<tr>
<td>Temperature</td>
<td>-22 degrees Fahrenheit</td>
</tr>
<tr>
<td>Maximum Temperature</td>
<td>+ 176 degrees Fahrenheit</td>
</tr>
</tbody>
</table>

F. Rope
1. Polypropylene rope: Polypropylene rope for lacing the shade to the frame shall be ultra violet resistant and have sufficient capacity to carry the weight of the shade, tension force and any wind and live loads applied to the fabric panel.

PART 3 - EXECUTION

3.1 INSTALLATION AND SAFETY PROCEDURES

A. The Contract Work to be performed shall consist of furnishing all labor, materials, equipment, parts, and supplies necessary for installation.

B. Shade shall be attached to steel frame using polypropylene rope.
   1. Shade shall be taut and be sloped to drain as indicated on the Drawings.

++ END OF SECTION ++
SECTION 10800

TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidental 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. Waste receptacles.
      c. Toilet tissue dispensers.
      d. Mirrors.
      e. Soap dispensers/shelves.
      f. Miscellaneous fasteners, accessories and trim as required for a complete and functioning installation.

B. Coordination:
   1. Refer to concrete and masonry Sections of these Specifications for installation of inserts and anchorage devices. Refer to and comply with the requirements of Section 04201, 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.
   2. ANSI A117.1, Accessible and Usable Buildings and Facilities.
   3. Americans with Disabilities Act of 1990 (ADA) Title II ADAAG.
C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel; Steel Plate, Sheet and Strip.
   3. ASTM A386 Specification for Zinc Coating (Hot-Dip) on Assembled Steel Products.
   7. FS WW-P-541, Plumbing Fixtures (Land Use).

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 A167: 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 A366: Cold rolled, commercial quality. Surface preparation and metal pretreatment as required for applied finish.

D. Chromium Plating, ASTM B456: 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 A386: 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.
   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.
   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. 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:
      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.
   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.
   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 ANSI A117.1 and the 2012 Phoenix Building Construction 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 exposed mounting devices and fasteners finished to match the accessories.

E. Provide theft-resistant fasteners for all accessory mountings.

F. Secure and install toilet room accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

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.
SECTION 11000

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 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.
   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.674: Electric Motors and Generators for Use in Class I Division I Hazardous Locations
11. 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 degrees C.
2. Resistive Unbalance and Quarter Voltage Impedance, as applicable.
3. Locked-Rotor current (Single phase).
5. No-Load Excitation (volts, amperes, RPM).
7. Efficiency, Power Factor, Current at 115%, 100%, 75%, 50%, and no load.

D. Warranty: Motors 1/2 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 01600, 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.
   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 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.

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 (122°F) and above, refer to the driven equipment specifications for additional requirements.
<table>
<thead>
<tr>
<th>Insulation System Class</th>
<th>Degrees C / F</th>
<th>Temperature Rise by Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>140 / 284</td>
<td>NA</td>
</tr>
<tr>
<td>B</td>
<td>165 / 329</td>
<td>B-rise: 40 + 80 = 120 Degrees C / 248 F</td>
</tr>
<tr>
<td>F</td>
<td>190 / 374</td>
<td>F-rise: 40 + 105 = 145 Degrees C / 293 F</td>
</tr>
<tr>
<td>H</td>
<td>215 / 419</td>
<td>H-rise: 40 + 125 = 165 Degrees C / 329 F</td>
</tr>
</tbody>
</table>

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.

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. Explosion-Proof motors: Indicate UL frame temperature limit code.
   4. Space heater information.
   5. 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 and explosion proof motors.

10. Each stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.

11. Insulation materials shall be non-hygrosopic 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.

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.

2.3 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 480 volts, 3 phase, 60 Hz, and shall be continuous time rated in accordance with NEMA Standard MG 1, Paragraph 10.35.

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-hygrosopic.
      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. 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:

<table>
<thead>
<tr>
<th>HORSEPOWER RANGE</th>
<th>SPEED, RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1200</td>
</tr>
<tr>
<td>1-2</td>
<td>82.5</td>
</tr>
<tr>
<td>3-5</td>
<td>89.5</td>
</tr>
<tr>
<td>7-25</td>
<td>90.2</td>
</tr>
<tr>
<td>30-60</td>
<td>92.4</td>
</tr>
<tr>
<td>75-250</td>
<td>94.1</td>
</tr>
</tbody>
</table>

E. 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.

F. Lifting Eyes:
1. Motors weighing more than 50 pounds shall be fitted with at least one lifting eye.

G. 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. 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 01781, Operation and Maintenance Data. Provided overhaul instructions for each motor five HP and over.

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

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 13119

ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Provide all labor, equipment, materials, and incidentals as required to furnish, install, check, calibrate, test, document, start-up, and place in satisfactory operation the Odor Control System as shown on the Drawings and as specified.
   2. The Odor Control System shall include, but not be limited to the following:
      a. Biofilter Structure as shown on the Drawings. (CONTRACTOR provided).
      b. Centrifugal Fiberglass Fan (Blower). (Biofilter Manufacturer provided).
      c. FRP Sound Enclosure for the foul-air fan. (Biofilter Manufacturer provided).
      d. Control Panel. (CONTRACTOR to provide if not provided by Biofilter Manufacturer).
      e. Irrigation System. (Biofilter Manufacturer provided).
      f. Media, Drain Rock, and Rock Cover. (Biofilter Manufacturer provided).
      g. Interconnecting fiberglass reinforced plastic (FRP) and HDPE ductwork, fittings, accessories, and supports from the fan through biofilter. (CONTRACTOR provided).
      h. Air plenum, air header, distribution pipe within biofilter. (Biofilter Manufacturer provided).
      i. Drain pipe within Biofilter (CONTRACTOR to provide if not provided by Biofilter Manufacturer).
      j. Dampeners. (CONTRACTOR to provide).
      k. FRP Grease Filter. (Biofilter Manufacturer provided).
      l. Spray bar on inlet of the biofilter. (Biofilter Manufacturer provided when necessary for proper operation).
      m. Flex Couplings. (CONTRACTOR to provide if not provided by Biofilter Manufacturer).
      n. Ductwork on inlet and discharge side of fan per Technical Specification 15108. (CONTRACTOR provided).
      o. Spare parts specified. (CONTRACTOR to provide if not provided by Biofilter Manufacturer).
   3. Work required under this specification consists of furnishing a complete Biofilter Odor Removal System for the control of atmospheric hydrogen sulfide, organic sulfur compounds, and other malodorous compounds associated with a municipal wastewater facility.
4. All components of the biofilter system shall be compatible with the conditions to which they are subjected during the normal operation of the system. Compounds with which the materials must be compatible include, but are not limited to:
   a. Hydrogen sulfide.
   b. Sodium hydroxide.
   c. Sodium hypochlorite.
   d. Acids.

B. Process Description:
1. The system shall remove hydrogen sulfide and other "sewer odor" causing compounds from the air stream via break down by microorganisms in the media. The air stream is introduced into the media with a fan. The biofilter shall be equipped with an irrigation system to maintain the moisture level in the biofilter media.
2. The contaminated air shall enter the biofilter through a distribution header. After treatment in the biofilter, the air shall exit the filter at the surface.

C. Service Conditions:
1. The biofilter system shall be designed to incorporate provisions to meet the following service conditions:
   a. Temperature Ranges: 0 degrees Fahrenheit to 120 degrees Fahrenheit.
   b. Precipitation: Approximately 11 inches per year.
   c. Altitude: Approximately 1350 feet above mean sea level (MSL).
2. The biofilter system shall be designed to treat 800 acfm of continuously ventilated air. This system shall be designed to eliminate odorous compounds from the airstream typical of a municipal wastewater facility. These compounds shall include, but not be limited to, hydrogen sulfide, mercaptans, reduced sulfur compounds, and volatile organic compounds typical of this type of application.

D. Performance Criteria:
1. Olfactory Performance: The biofilter shall emit no nuisance odors and have no detectable odors within a distance of thirty (30) feet of the bed.
2. Media Life: The media shall have a minimum useful life of ten (10) 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.
3. The biofilter design shall utilize a media type that does not require/include chemicals, polishing, compost, wood chips, and other types of pure organic media.
4. The maximum allowable pressure drop through the biofilter media shall be 2 inches of water column (WC) per foot depth.
5. Furnish Biofilter to meet the following minimum criteria:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Capacity</td>
<td>800</td>
<td>acfm</td>
</tr>
<tr>
<td>Average H₂S Loading</td>
<td>1.0</td>
<td>ppm</td>
</tr>
<tr>
<td>Peak H₂S Loading</td>
<td>44.5</td>
<td>ppm</td>
</tr>
<tr>
<td>Minimum H₂S Removal Efficiency (&gt;10 ppm)</td>
<td>99.0</td>
<td>%</td>
</tr>
<tr>
<td>Maximum H₂S discharge concentration (&lt;10 ppm)</td>
<td>0.1</td>
<td>ppm</td>
</tr>
<tr>
<td>Biofilter Area (Based on Biofilter Manufacturer Design, MAXIMUM)</td>
<td>225</td>
<td>sf</td>
</tr>
<tr>
<td>Media Depth (Based on Biofilter Manufacturer Design, MINIMUM)</td>
<td>5</td>
<td>ft</td>
</tr>
<tr>
<td>Empty Bed Residence Time (Based on Biofilter Manufacturer Design, MINIMUM)</td>
<td>30</td>
<td>seconds</td>
</tr>
</tbody>
</table>

6. Performance testing criteria is specified in Section 3.09 B.

1.02 QUALITY ASSURANCE

A. Qualifications: Odor Control fan furnished under this Section shall be supplied by a single manufacturer. Manufacturers of equipment furnished under this Section shall have been regularly engaged in the design and manufacture of the equipment for at least five years. Demonstrate to the satisfaction of the Construction Manager that the quality is equal to equipment made by those manufacturers named herein.

B. The manufacturer shall maintain regular production facilities at their place of business. These facilities shall be open for inspection by a representative of the OWNER or ENGINEER at any time during construction and testing of this equipment.

C. The supplier of the biofilter media shall be one of the following:
   2. BIOREM Technologies Inc.
   3. or Pre-Approved Equal per Section 00100.

D. Shop Tests:
   1. Fan (Blower) Tests:
      a. Performance Testing: Submit certified non-witnessed factory performance test results. Receive favorable review of test results prior to shipping the equipment.
      b. All materials, labor and equipment for all tests and retests shall be furnished by CONTRACTOR.
c. Fan wheels shall be statically and dynamically balanced.

E. Installer Qualifications:
   1. Engage a single installer with undivided responsibility for performance and other requirements who is 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.

F. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Local and State Building Codes and Ordinances:
      b. The BOCA National Mechanical Code.
   3. Underwriters' Laboratories, Incorporated (UL).

G. Responsibilities:
   1. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.
   2. The sole responsibility for proper operation of the Odor Control Systems shall rest with CONTRACTOR.
   3. Unit Responsibility: Assign Unit Responsibility as specified in Section 01600, General Equipment Provisions, to the manufacturer or supplier for the equipment specified in this Section.
   4. The complete fan assembly including the motor shall be hazardous location field certified by an approved OSHA Company, this is the responsibility of the CONTRACTOR. Copies of field certifications shall be provided to the OWNER and ENGINEER.
H. Materials Testing:
   1. Material employed in items fabricated of fiberglass reinforced plastic shall be capable of withstanding maximum calculated stresses that may occur during fabrication, installation and continuous operation, with allowance for an adequate safety factor. To confirm materials properties, tests shall be conducted by an independent, qualified testing laboratory on representative material samples in accordance with the following latest revision of ASTM standards:
      a. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
      b. Sheet Metal and Air Conditioning Contractors National Association (SMAC-NA):
         1) HVAC Duct Construction Standards.
      c. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 125.
      d. ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
      e. ASTM C582, Specification for Contact-Molded Reinforced Thermosetting Plastic Laminates for Corrosion Resistant Equipment.
      g. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
      h. ASTM D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
      j. ASTM D883, Terminology Relating to Plastics.
      k. ASTM D1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
      l. ASTM D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
      m. ASTM D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
      n. ASTM D2310, Classification for Machine Made Fiberglass Pipe.
      q. ASTM D2996, Specification for Filament-Wound, Fiberglass Pipe.
      s. ASTM D3299, Specification for Filament-Wound Glass-Fiber-Reinforced Polyester Chemical Resistant Tanks.
      u. ASTM D4097, Standard Specifications for Contact Molded Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks.
w. ASTM F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
x. NBS Voluntary Product Standard PS15-69 Custom Contact Molded Reinforced-Polyester Chemical-Resistant Process Equipment.

2. Test results shall be submitted for review and approved by ENGINEER prior to manufacturer of fiberglass reinforced plastic items.

I. Prior to conducting any Odor Control System testing, demonstrate that all meters and test equipment have been calibrated, charged and are in good operating condition one working day before the test date. CONTRACTOR shall also verify there is sufficient test gas to conduct testing for specified durations at specified concentrations.

J. Provide certifications that all stainless steel accessories including hangers and supports for FRP and HDPE ductwork that are Type 316 stainless steel.

1.03 SUBMITTALS

A. Manufacturers shall submit complete shop drawings and engineering data to the OWNER or ENGINEER. These submittals shall include, at a minimum:
   1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the Specifications.
   2. Motor data.
   3. System layouts and/or schematics, including mounting details.
   4. Elementary and connection wiring diagrams clearly showing external connections to other equipment.
   5. Motor designation and horsepower.
   6. Bill of material including spare parts being furnished.
   7. Manufacturers catalog information on major system components, including but not limited to:
      a. Fiberglass Centrifugal Fan, including fan curves.
      b. Media.
      c. Irrigation System.
   8. Statement of design conditions and performance guarantee.
B. The Manufacturer shall submit complete Operation and Maintenance Manuals to the OWNER per Section 01781, Operations & Maintenance Data. These manuals shall include, at a minimum:

1. Information on hazards associated with the system and appropriate safety precautions.
2. Equipment installation instructions.
3. Equipment startup instructions.
4. Equipment maintenance procedures.
5. Troubleshooting guide.
6. Individual operation and maintenance information on major system components, including but not limited to:
   a. Fiberglass Centrifugal Fan.
   b. Media.
   c. Irrigation System.
      1) Include irrigation schedule for all weather seasons.
7. Performance test certificates and reports.
8. Field test certificates and reports.

1.04 SUBSTITUTIONS

A. Any substitutions or deviations in equipment or arrangement from that shown on the drawings or specified herein shall be the responsibility of the Manufacturer or CONTRACTOR. Any deviations must be accompanied by detailed structural, mechanical, and electrical drawings and data for review by the ENGINEER. All costs associated with review of substitutions or deviations and costs associated with project drawing changes as a result of approval of such shall be borne by the Manufacturer or CONTRACTOR. There shall be no additional costs to the OWNER due to substitutions or deviations.

1.05 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.

1. Responsibility belongs to CONTRACTOR for safe transportation, including all freight costs for delivery to the job site, procuring any necessary permits, handling, and open air storage of the fan and other materials purchased as specified in this Section.

2. 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 other equipment.
3. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.
4. The fan shall come completely assembled and protected against entry of foreign objects.
5. Suction and discharge ports shall be protected against entry of foreign objects.
6. Store equipment and materials so as to keep free from moisture, damage, and deterioration.
7. Openings shall be covered to protect flange surfaces and to prevent foreign materials from entering the vessels.
8. Ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment.
9. Biofilter media delivery, storage, and handling shall comply with Manufacturer's instructions.

B. All boxes, crates and packages shall be inspected immediately 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 materials off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

1.06 EQUIPMENT INSPECTIONS

A. Inform OWNER and ENGINEER, four weeks prior to when specific equipment (e.g., fan and ductwork) goes into production, so that OWNER and ENGINEER, at their option, may visit premises prior to shipment of any equipment for approval of various items of major equipment. Manufacturer of major equipment shall not ship any equipment until ENGINEER has inspected and approved equipment, or manufacturer receives written permission from ENGINEER to ship equipment.

B. Factory inspection by ENGINEER shall not be construed to relieve CONTRACTOR of responsibility for accuracy of the fabrication and assembly, or the quality of workmanship.

C. A thorough inspection of each piece of equipment will be conducted upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be immediately repaired by respective equipment fabricator's personnel only, not a sales representative.
1.07 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. Examine all the Contract Documents for conditions, which may affect the installation of his Work, and shall arrange his Work accordingly. Provide all required items to complete the systems to the extent required by the Contract Documents.

C. If piping or ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete Shop Drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.

1.08 EQUIPMENT DEFECTS

A. Equipment, which have mechanical defects and that do not meet vibration requirements, will be rejected and shall be replaced at CONTRACTOR’S full expense for furnishing, installing, removal, and replacement.

B. Mechanical defects shall include excessive vibration, improper balancing of rotating parts, improper tolerances, binding, excessive bearing heating, defective materials, improper fitting of parts, and any other defect which will in time damage the equipment or impair its operation.

C. Requirements shall be met concerning minimum and maximum dimensions and the specifications for materials. If it is found upon delivery that materials do not agree with the requirements of the Specifications as to size, type, quality, or metallurgy, they will be rejected as unfit for use in this Work.
PART 2 - PRODUCTS

2.01 BIOFILTER MEDIA

A. Plenum Zone Material/Base Media: Coarse gravel as approved by System Supplier.

B. Biofilter Media:
   1. The media shall be an engineered type; consist of inorganic, inert hydrophilic cores; shall not shrink or swell under varying moisture conditions; and shall be formulated with nutrients, buffering agents and adsorbents.
   2. The media shall be as tested and approved by the System Supplier.
   3. Media development; blending, amendment components and quantities, and laboratory analysis, shall be the responsibility of the System Supplier.
   4. The media shall be delivered and the CONTRACTOR shall maintain the conditions per the system supplier. Media shall be placed in a uniform manner that will prevent aggregation and compaction of materials, and prevent displacement of the air piping.

C. Rock Cover: Material as approved by System Supplier and OWNER.

2.02 FOUL AIR PIPING

A. Pipe lengths and fittings shall be supplied by the same manufacturer.

B. Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin.

C. Main Air Header Manifold Pipes:
   1. Main air header manifold pipes shall be HDPE pipe meeting all requirements of AASHTO M294, Type S.
   2. Manufacturer shall weld stubs onto the air header manifold pipes for the HDPE lateral connections.
      a. Stubs shall consist of a short length of SDR 32.5 HDPE welded flush into the header manifold pipe and a short length of corrugated HDPE welded onto the other end.
      b. Total length of the stub shall not exceed 12 inches.
      c. No stubs shall be welded at a bell and spigot joint.
      d. Stub spacing shall per System Supplier's requirements.

D. Air Distribution Laterals:
   1. Laterals shall be corrugated and slotted HDPE pipe meeting all requirements of AASHTO M252, Type CD.
   2. Slot size and quantity shall be as recommended by the System Supplier.
E. Fittings: Snap type or factory welded with HDPE welds per manufacturer's standard procedures and requirements.

F. Manufacturer:
1. Advanced Drainage Systems (ADS), Inc.
2. Or approved equal.

2.03 IRRIGATION SYSTEM

A. The biofilter system shall include an irrigation system for moisture control of the media. The irrigation system shall include piping, sprinklers/drippers, a solenoid control valve and filter, isolation valve, flow totalizer (if required by manufacturer), and an irrigation controller.

B. The layout of the irrigation system and the number of irrigation zones shall be determined by the Odor Control System Supplier.

C. Drip Tubing: Drip tubing shall be Netafim Techline CV, or equal. The flow rate for each emitter shall be 0.9 gph and spaced 12 inches on center.

D. Spray Irrigation System shall consist of a schedule 80 CPVC manifold with spiral spray nozzles.

E. Control Valve: The irrigation control valve shall be a Rain Bird XCZ-100-PRB-LC 1-inch scrubber valve with integral filter and pressure reducing valve, or approved equal. Valve shall be supplied with 24V ac coil and fail closed on a loss of power. Valve shall be located 3 feet from any potential leak point to comply with NFPA 820.

F. Irrigation Control System: The irrigation control system shall consist of a Rain Bird Model ESP-Me sprinkler timer or approved equal. Electrical input required: 120 VAC ± 10%, 60 Hz. Electrical output: 24 VAC. Provide a NEMA 4X, 316 stainless steel junction box for installation of the sprinkler timer. The irrigation control system shall be located 3 feet from any potential leak point to comply with NFPA 820.

2.04 CONTROL PANEL

A. Panel shall contain the local control and monitoring components for the odor control system, including:
1. NEMA 4X 316 stainless steel enclosure with pedestal legs if required.
2. Door-mounted disconnect.
3. Hand/Off/Auto switch for fan.
5. Alarm reset push button.
6. Dry contacts for transmitting signals to remote location.

B. UL Certified.

C. The panel shall be located 3 feet from any potential leak point to comply with NFPA 820.

2.05 FOUL AIR FAN

A. Characteristics:
1. Fan Design/Construction: In accordance with ASTM D4167.
3. Fan Impeller selection based on airstream:
   a. Medium duty, semi-dirty to partial particulate/dusty conditions - Forward curved, radial tipped impeller.
4. The shaft shall be connected to the impeller by means of a steel taper-lock bushing for ease in changing fan impeller, shafts, and bearings. The steel hub is to be encapsulated with FRP and extend outside of the fan housing. The bushing is to be welded to a Carbon Steel plate and then encapsulated with FRP to form the back plate of the impeller. Replacing the impeller, shaft, or bearing shall not require any FRP bonding or repair.
5. Shaft: Shaft material shall be 316 stainless steel.
6. Shaft Bearings: Heavy duty, self-aligning, minimum ABMA L10 life rating of 100,000 hours, grease lubricated with lube tubes extended to outside of housing.
7. Shaft Seal: Provide Teflon shaft seal.
8. Duct Connections: Plain or Flanged per Drawings.
9. Drain: Provide FRP pipe bonded to a low point in the housing and flush to the interior housing surface.
10. Provide a bolted and gasketed access door which shall be flush with the interior of the fan housing if applicable.
11. Fan Arrangement: 9 or 10 per AMCA Standards based on fan size.
13. Electrical Grounding: Coat airstream surfaces with graphite impregnated resin with grounding straps to motor frames or fan base to control static electricity.
15. Drive:
   a. Selection shall be for a minimum 1.5 Service Factor.
16. FRP requirements:
   a. Suitable for continuous operation when exposed to vapors and gases expected in a sewer lift station including but not limited to hydrogen sulfide, ammonia, methane, carbon monoxide, sulfur dioxide, and nitrogen.
b. Housing: The fan housing shall be constructed of premium grade vinyl ester resin (Ashland Chemical Derakane 510B-400 or approved equivalent) in accordance with ASTM D4167 to ensure structural integrity. Airstream surfaces shall be smooth to minimize resistance and prevent build-up of airborne contaminants. Resin to be fire retardant with an ASTM E84 of 24 or less without the use of fire retardant additives. All exterior FRP surfaces shall be resin rich using a paraffinate resin stabilized against ultraviolet degradation. The exterior surface shall be further enhanced with a "C" grade surface veil for further protection against atmospheric fumes and spills. Immediately beneath the surface veil of the interior surface of the laminate will be a layer of chopped strand mat (CSM). The CSM will be a commercially available type "E" glass of 2 oz. per square foot weight. No woven roving shall be accepted. All internal metal components must be encapsulated in FRP and have no contact with the airstream.

c. Impeller: The fan impeller shall be constructed of premium-grade vinyl ester resin in accordance with ASTM D4167 and the laminate shall meet or exceed the requirements for defects per ASTM D2563 Level II. Customer inspections are available to ensure compliance. The fan impellers shall be made using a non-fire retardant vinyl ester resin chosen for strength characteristics. Resin for the fan impellers is to be DION 9800 or approved equal. Steel impeller hub shall be encapsulated in FRP to insure corrosion-resistant integrity and constructed so that the shaft remains outside of the airstream. Metal impellers coated with FRP, or impellers permanently bonded to shaft, are not acceptable.

d. Provide Veil-Nexus corrosion-resistant surfacing veil and additional coat of fiberglass reinforced plastic resin on surfaces exposed to the airstream for corrosion resistance and chopped strand fiberglass for structural core strength.

e. Protect fiberglass surfaces with minimum 10 mil thickness of ultraviolet resistant resin (or 2-part epoxy coating) after initial visual inspections of housing exterior is complete.

17. Balance and Run Test: The impeller and shaft shall be dynamically balanced as an assembly to ISO Quality Grade G2.5. Fan will be statically and dynamically balanced at its operating speed as a complete unit with the actual motor and drive. The balancing will be in accordance with AMCA 204, Section 6, Table 6-3 to a maximum of 0.078 in./sec. velocity (approximately 0.5 mils peak-to-peak @ 1,000 rpm) Balancing adjustments to the fan impeller will be performed by adding FRP of the same material as the impeller. Balance weight thickness shall not exceed 1/4 inch. No lead weights or other metals will be used for balancing.

18. Fan Details:
   a. Flow rate: 800 acfm.
   b. Static pressure: As determined by biofilter manufacturer.
   c. Fan rpm: As determined by biofilter manufacturer.
   d. Operating power: As determined by biofilter manufacturer.
19. Motor Details:
   a. HP (As determined by biofilter manufacturer), 230/460V, 3-phase, 60 Hz, Premium Efficiency Explosion Proof.
   b. Motors shall conform to the requirements of Section 11000, Electric Motors.
   c. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, Phoenix Electrical Code, and ANSI.
   d. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 50 degrees Celsius.
   e. Motors shall be provided with a service factor of 1.15.
   f. Motors shall be of sufficient size so that there will be no overload on the motor above rated manufacturer's nameplate horsepower under any condition of operation.
   g. Motor thrust bearings shall be adequate to carry continuous thrust loads of fan operation.
   h. Locked rotor currents shall be as specified in NEMA standards.
   i. Lubrication may be grease or oil type.

20. Manufacturer:
   b. Hartzell
   c. Or approved equal.

2.06 FRP SOUND ENCLOSURE

A. Provide a sound enclosure so the foul air fan noise emitted is less than 50 dB within 4 feet of the foul air fan.

B. Manufacturer:
   1. FanAir Company.
   2. Daniel Company.
   3. Or approved equal.

2.07 GREASE FILTER

A. Characteristics
   1. Grease Filters shall be designed for a maximum of 3/4-inch Water Gage Static Pressure resistance at a design capacity of 1,000 acfm.
   2. Grease Filters shall be single stage horizontal type constructed in Fiberglass Reinforced Plastic with 316 SS Filters and shall have a 99% removal efficiency at 12 Microns.
   3. Grease Filter housing shall be fabricated in accordance with NBS PS-15-69, from premium grade fire-retardant vinyl ester resin and Fiberglass cloth. Resin shall be Ashland Chemical Inc., Hetrion FR992, Flame Retardant, Corrosion
Resistant, Epoxy Vinyl Ester Resin. The above resin system shall have a flame spread rating of 15 or less, when tested per ASTM-E 84 tunnel test. The above resins shall not contain any fillers except as required for viscosity control.

4. Grease Filter housings shall be constructed using laminate construction consisting of an inner surface or "C" glass veil, an inner layer and an exterior layer or laminate body. No cracks or delaminating will be permissible.

5. Grease Filters shall have both a flanged inlet and discharge and be provided with EPDM gaskets. Flange connections shall be a Minimum of 3/8-inch Thickness and to be shop drilled.

6. Grease Filter housings shall be a minimum of 1/4-inch thickness and shall have an adequately sized access panel for inspection and removal of Filters or Filter Media trays. Access panels shall be provided with EPDM gaskets and 316 SS fasteners.

7. Grease Filter elements shall be processed from Stainless Steel sheet, expanded to 0.032 strand. The filtering media shall consist of no less than 7 layers of corrugated Stainless Steel, expanded through specified feeds to assure maximum filtering and internal loading capabilities. The Frame shall be one piece, formed Stainless Steel channel, made from type 304 Stainless Steel, not less than .024 thickness. The filter element will be joined with Stainless Steel Rivets. Holes will be punched on one side to allow for proper drainage after cleaning and when used in a grease filter application. Filters shall retain 240 grams of grease or 300 grams of dust per 2.25 sq. ft. (20 x 20 filter). Resistance when clean is 0.075 WG at 350 FPM air velocity.

8. Grease Filters shall be provided with a Dwyer Model 2000 Magnehelic Differential Pressure Gage with Red pointer flag indicator. Gage shall be factory installed using 2 Each, Dwyer A-301SS Stainless Static Pressure Tips and 1/8-inch vinyl tubing to gage.

9. Grease Filter Housings shall be sanded smooth, inspected for cracks, or loose fibers and receive a final coat of 15 Mils (minimum) Gel coat with UV stabilizers.

10. Grease Filters shall be suitably packaged for shipment. Wood skids shall be used with protective covers placed over intake and discharge flanges.

11. Manufacturer
   a. Grease Filters shall be as manufactured only by companies with a minimum of 5 years manufacturing experience of Municipal Air Filtration Systems.
   b. Grease Filters shall be as manufactured by FanAir Company, Daniel Company Inc., or approved equal.

2.08 DAMPERS

A. Balancing Damper
   1. Fiberglass Heavy Duty Industrial Round Damper:
      a. Service: Air systems up to 30 inches water column; up to 6,000 feet per minute velocity and up to 72 inches diameter.
b. Size and installation: Size as indicated on the Drawings suitable for flange mounting in round ducting.

c. Frame: Vinyl ester resin fiberglass construction conforming to ASME RTP1 with 30 mil resin rich interior corrosion layer; flanges integral to the web layup.

d. Blade: Vinyl ester resin fiberglass, stiffened as required; provide 30 mil resin rich corrosion layer on both sides; provide Viton elastomer edge seal.

e. Blade axle: Vinyl ester resin fiberglass rod with PTFE bearings and axle shaft seal.

f. Manufacturers: The following or equal:
   1) Swartwout, Model 914.
   2) Daniel Company.
   3) Ruskin Manufacturing.
   4) American Warming and Ventilating.

2.09 SPRAY NOZZLE

A. Characteristics:
   1. Shall be quick disconnect type for ease of maintenance.
   2. Shall be of material resistant to conditions identified in Section 1.01.A.4 or be coated to be resistant.

2.10 SPARE PARTS

A. Spare Parts:
   1. One (1) set of replacement drip tubes or sprinkler nozzles shall be furnished.
   2. One (1) spare fan motor shall be furnished.
   3. One (1) spare spray nozzle shall be furnished when included in the original biofilter equipment.

PART 3 - EXECUTION

3.01 SITE AND UTILITIES

A. The fan and other appurtenances shall be located on a foundation as shown in Drawings.
   1. Electrical: As noted above for fan (blower) and irrigation system.
   2. Water Supply: A 3/4-inch water supply with backflow preventer shall be required. Water supply must provide for a minimum of 40 psi continuous pressure and a hardness not to exceed 100 mg/L as calcium carbonate.
   3. Drain: A minimum 6-inch PVC, SCH 40 gravity drain to the wet well shall be required.
3.02 EQUIPMENT SHOP TESTING

A. Before shipping the equipment, the Manufacturer shall perform shop tests. These tests shall include at a minimum:
   1. Visual inspection of all equipment.
   2. Complete assembly and functional operation testing of equipment.

3.03 GENERAL INSTALLATION

A. The system shall be installed in accordance with the manufacturer's instructions. Installation personnel shall be trained and qualified in the areas of plumbing, electrical work, and instrumentation as required to complete the installation.

3.04 ODOR CONTROL SYSTEM INSTALLATION

A. General:
   1. Elevations shall be surveyed at the structure floor, top of plenum zone/base media, and top of biofilter media to establish correct slope and correct thickness of each layer.
   2. Per Section 3.05, materials are not to be compacted.

3.05 PLACING MEDIA/GRAVEL MATERIALS

A. Placement Into Bed:
   1. Plenum zone/base media shall be placed in a manner that will limit displacement of the HDPE lateral pipes.
   2. Plenum zone/base media shall be leveled and undisturbed prior to media placement. Do not permit workers to walk or stand directly on 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.
C. Bedding, Plenum Zone/Base Media, and Media:
   1. Place in layers as specified below:

<table>
<thead>
<tr>
<th>Gravel Layer</th>
<th>Layer Thickness</th>
<th>Size Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plenum Zone/Base Media</td>
<td>Per Drawings</td>
<td>1 inch - 1/2 inch</td>
</tr>
<tr>
<td>Media</td>
<td>Per Drawings</td>
<td>Per System Supplier</td>
</tr>
<tr>
<td>Cover Rock</td>
<td>Per Drawings</td>
<td>2 inches – 3/8 inch</td>
</tr>
</tbody>
</table>

   2. Complete each layer before next layer above is started.
   3. Use only clean gravel. CONTRACTOR shall be responsible to avoid contamination of materials by native fill dirt or other.

3.06 ODOROUS AIR PIPING INSTALLATION

A. Examination: Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Preparation: Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

C. Installation–General:
   1. Joint pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
   2. Remove foreign objects prior to assembly and installation.

D. Flanged Joints:
   1. Install perpendicular to pipe centerline.
   2. HDPE flange with no bolt holes.
   3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
   4. Use flat-face flange when joining with flat-faced FRP flange. Use minimum 1/4 inch thick neoprene gaskets.

3.07 AIR DISTRIBUTION PIPE INSTALLATION

A. Placement:
   1. Keep trench dry until pipe laying and joining are completed.
   2. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe and stubs.
   3. Measure for grade at pipe invert not at crown.
   4. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
5. Prevent foreign material from entering pipe during placement.
6. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
7. Lay pipe upgrade with bell ends pointing in direction of laying.
8. After joint has been made, check pipe elevation at pipe ends and corners of media piping network.

B. Smoke Testing:
1. Smoke testing shall be completed after the plenum zone/base media is installed over the air distribution pipe. This test is to demonstrate uniform air flow distribution throughout the biofilter area.
2. CONTRACTOR shall give two weeks written advance notice to ENGINEER, OWNER, and media manufacture for witnessing the test. Any broken or damaged air distribution pipe shall be replaced or repaired. Media manufacture shall be onsite to witness the test. CONTRACTOR shall adjust the air collection system to achieve uniform air flow distribution.
3. CONTRACTOR shall submit for approval to the ENGINEER or OWNER a plan showing the procedures for smoke testing, locations of the smoke devices, and the type and model numbers. Smoke devices shall be of the nontoxic, non-residue type and generate white smoke.
4. Prior to starting smoke testing the CONTRACTOR shall inform the OWNER and local fire authority and warn all personnel and staff within the area so that they are aware of the use.
5. The quantity, output, and locations of smoke devices shall be coordinated with the ENGINEER or OWNER prior to testing. CONTRACTOR shall allow in the bid for sufficient smoke devices/generators for three smoke tests. Each smoke test shall have a capacity of 1,000 cfm and duration of 20 minutes.

3.08 FOUL AIR FAN

A. Inspection:
1. Examine Pads to Receive Fans for:
   a. Proper anchor bolt locations.
   b. Unevenness, irregularities and incorrect dimensions.

B. Installation:
1. Installation shall be in accordance with the manufacturer's instructions and recommendations.
2. Installation shall include furnishing and applying an initial supply of grease as recommended by the manufacturer.
3. Ductwork shall be supported independently of fan.
4. Check and align fan and motor.

C. Start-Up Adjustment and Testing:
1. Grease bearings, if required, prior to starting fans.
2. Check for proper rotation.
3. Adjust fans for proper air flow.
4. Leave fans in working order.

D. Cleaning:
1. Clean dirt and marks and other debris from exterior of fans.
2. Remove debris and waste material resulting from installation.

3.09 TESTING REQUIREMENTS AND START-UP

A. CONTRACTOR shall CCTV the air header and distribution piping (via the cleanouts) to confirm the piping has no obstructions and is not deformed. This shall be done after the Odor Control System has been installed and operational but prior to the performance and sampling testing. Provide CCTV footage to ENGINEER and OWNER seven days prior to performance and sampling testing. If the piping has obstructions the CONTRACTOR shall remove them, CCTV the pipes again and provide CCTV footage to ENGINEER and OWNER seven days prior to performance and sampling testing. If the piping is deformed it shall be removed and replaced.

B. Test Procedures: The time of the tests and detailed test procedure shall be submitted for approval prior to the testing period. In the event hydrogen sulfide levels are below anticipated levels, the CONTRACTOR shall provide verifiable test data demonstrating system can remove design concentration levels.

C. Performance Testing:
1. General:
   a. To demonstrate that the odor control system furnished hereunder is installed and performs in accordance with the provisions of these Specifications, the System Supplier shall conduct a four (4) hour 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. The System Supplier shall provide, install, and maintain, if required, all temporary metering or analytical equipment necessary to measure the various performance parameters.
   c. 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.
   d. 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 odor control system 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.
   c. The actual sample day shall be chosen to limit weather interference.
3. Sampling and Data Measurement: During the test period, at a minimum, the
   following data and measurements shall be taken at the frequency indicated:
   b. Fan discharge pressure in inches of WC: Initially.
   c. Unit airflows (cfm/ft²) shall be taken at six (6) locations across the
      biofilter; two corners and four 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.
i. Results: A description of the performance tests shall be submitted. The hydrogen sulfide compound removal efficiency shall be as specified in the design and performance requirements. Should the biofilter performance not meet any of the above requirements, the system shall have failed the performance tests. The CONTRACTOR shall make any additions or modifications to the biofilter system as may be necessary, at no additional cost to the OWNER, and the performance tests for that system shall be repeated in its entirety.

4. Test Reports for Fan (Blower):
   a. AMCA Label.
   b. UL Label.

D. Start-up: The services of a factory representative shall be provided as specified to insure proper installation and start-up of the biofilter system.
1. A representative for the System Supplier specified herein shall be present at the jobsite for the minimum person-days listed for the services hereinunder, travel time excluded:
   a. Three person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
   b. Two person-days for functional testing, operator training, and performance testing.

E. Maricopa County Emissions Permit Compliance Testing:
1. The testing will confirm the odor control biofilter has achieved a minimum 99.0 percent hydrogen sulfide removal. The testing will be conducted as specified herein and will be witnessed by the Maricopa County Environmental Services Department, Air Quality Division. A minimum 30-day advance notice of testing is usually required by the County in order to schedule their personnel. At least 60 days prior to biofilter testing, submit six copies of detailed testing protocol to the ENGINEER, who will review it and return it to CONTRACTOR to address ENGINEER'S comments. After the document has been modified by CONTRACTOR, CONTRACTOR and ENGINEER will meet with the County and will review the protocol as with the County's representative. Make modifications in the protocol as requested by the County.
2. The biofilter testing methods shall be specified in the appendices to 40 CFR Part 60 and the Maricopa County Air Pollution Control Rules and Regulations (Rules).
3. Provide the services of an independent consultant (Emissions Consultant) experienced in testing Odor Control System emission air quality for compliance with the requirements of Maricopa County Air Pollution Control Division (MCAPCD). The Emissions Consultant shall have a minimum of five years of odor control experience in emissions air quality testing in Maricopa County, Arizona. Submit the Emission's Consultant's statement of qualifications and experience to the ENGINEER for approval.
4. The Emissions Consultant shall perform all required testing and prepare a final report to demonstrate that the Odor Control System performs as specified herein, including the emissions requirements established by MCAPCD.

5. The Emissions Consultant shall be responsible for all testing procedures, to furnish, install, operate and maintain all testing and recording equipment, instruments and controls and to perform on-site calibration of all testing equipment. The Emissions Consultant shall prepare the protocol for a testing plan, secure testing plan approval from MCAPCD, provide written notice of the testing schedule to MCAPCD at least 30 days prior to initiating testing, conduct all tests (allowing the ENGINEER, OWNER and Maricopa County the option to witness the testing) and prepare a test report of the results. In the event that the Odor Control System, as constructed, does not meet the specified performance criteria of Maricopa County, make the required adjustments to the Odor Control System to bring the system into compliance. The Emissions Consultant shall retest the system as often as necessary to meet specified performance requirements.

6. Ten copies of a final test report suitable for submittal to MCAPCD shall be provided.

3.10 WARRANTY

A. The Manufacturer shall guarantee that the biofilter system will perform as described in these Specifications. The Manufacturer shall warrant centrifugal fan, biofilter, irrigation system, and other provided components to be free from defects in materials or workmanship for a period one (1) year after Substantial Completion. The Manufacturer shall warrant the biofilter media for a period of ten (10) years after start of initial operation. The Manufacturer shall repair or provide replacement for any defective components under this warranty.

++ END OF SECTION ++
SECTION 15050

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 Division 15, Mechanical. 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 01420 – References.
   i. 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.
   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 and elsewhere in Division 15, Mechanical, 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.
7. ANSI B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
8. ANSI B16.11, Forged Steel Fittings, Socket Welding and Threaded.
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.
14. ASME SECTION IX, Boiler and Pressure Vessel Code; Welding and Brazing Qualifications.
16. ASTM A53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
23. ASTM A312/A 312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
27. ASTM B88, Specification for Seamless Copper Water Tube.
29. ASTM C296, Specification for Asbestos-Cement Pressure Pipe.
35. ASTM D2513, Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
38. ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
40. ASTM D3262, Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
42. ASTM D4101, Specification for Propylene Plastic Injection and Extrusion Materials.
43. ASTM F441, 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.
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.
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.
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.
68. Phoenix Plumbing Code.
70. National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420 – 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 15050, Piping Systems, Section 15051, Buried Piping Installation, and Section 15052, 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 of Division 15, Mechanical.
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 01420 – 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.

B. 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 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 15051, 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. Harness lengths for pipe shall be determined by the pipe manufacturer in accordance with the formula in Section 15051, 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 15051, 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.

B. 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 01630, 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 01143, 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:

<table>
<thead>
<tr>
<th>Pipeline size</th>
<th>Specified Test Pressure</th>
<th>Testing medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch and smaller</td>
<td>75 psi or less</td>
<td>Air or water</td>
</tr>
<tr>
<td>2-inch and smaller</td>
<td>Greater than 75 psi</td>
<td>Water</td>
</tr>
<tr>
<td>Greater than 2-inch</td>
<td>3 psi or less</td>
<td>Air or water</td>
</tr>
<tr>
<td>Greater than 2-inch</td>
<td>Greater than 3 psi</td>
<td>Water</td>
</tr>
</tbody>
</table>

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. Drains:
   1. Drain systems, other than pumped drain systems, shall be tested in accordance with Phoenix Plumbing Code.
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:

<table>
<thead>
<tr>
<th>Equipment Suction or Piping Size, (Inches)</th>
<th>Maximum Screen Opening, (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1</td>
<td>1/16</td>
</tr>
<tr>
<td>1-1/4 to 3</td>
<td>1/4</td>
</tr>
<tr>
<td>3-1/2 to 6</td>
<td>1/2</td>
</tr>
<tr>
<td>Over 6</td>
<td>1</td>
</tr>
</tbody>
</table>

   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.
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. 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.

(The remainder of this page was left blank intentionally.)
### Table A - Piping Systems

<table>
<thead>
<tr>
<th>Article No.</th>
<th>System No.</th>
<th>Symbol</th>
<th>Service Descriptions</th>
<th>Fluid Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>7</td>
<td>PW</td>
<td>Potable Water</td>
<td>Water</td>
</tr>
<tr>
<td>3.9</td>
<td>22</td>
<td>FAD</td>
<td>Foul Air Duct</td>
<td>Foul Air</td>
</tr>
<tr>
<td>3.10</td>
<td>24</td>
<td>SW</td>
<td>Sanitary Waste</td>
<td>Drain/Vent</td>
</tr>
</tbody>
</table>

(The remainder of this page was left blank intentionally.)
3.8 SYSTEM - 7

Piping Symbol/Service: PW Potable Water

Test Requirements:
- Medium: Water: Refer to Paragraph 3.5.C., above.
- Pressure: Piping Systems: 200 psig for exposed ductile iron pipe, otherwise 125 psig.
- Duration: 60 minutes.

Gasket Requirements:
- Flange: Refer to Section 15101, Ductile Iron Pipe. Refer to Section 15101, Ductile Iron Pipe.
- Push-on/Mech Cpl: Refer to Section 15101, Ductile Iron Pipe.

Exposed Pipe/Valves:

3-inches and smaller
- Pipe: Copper Type K (rigid). Refer to Section 15105, Copper Pipe and Section 15105, Copper Pipe.
- Tube: Type K with polythene tape coating. Field application of coating to all couplings. Refer to Section 15105, Copper Pipe.
- Conn: Solder type, with threaded or flanged adapters for valves.
- Ftg's: Refer to Section 15105, Copper Pipe.

(The remainder of this page was left blank intentionally.)
### 3.9 SYSTEM - 22

<table>
<thead>
<tr>
<th>Piping Symbol/Service:</th>
<th>FAD</th>
<th>Foul Air Duct</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Test Requirements:</th>
<th>Medium:</th>
<th>Air: Refer to Paragraph 3.5.B., above.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure:</td>
<td>15 psig.</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Duration:</td>
<td>60 minutes.</td>
<td>---------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gasket Requirements:</th>
<th>Flange:</th>
<th>Gylon gasketing, Garlock style 3504.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push-on/Mech Cpl:</td>
<td>N/A.</td>
<td>---------------------------------------</td>
</tr>
</tbody>
</table>

#### Exposed Pipe/Valves:

<table>
<thead>
<tr>
<th>All sizes</th>
<th>Pipe:</th>
<th>FRP: Refer to Section 13119, Biofilter System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conn:</td>
<td>Butt weld or flanged.</td>
<td></td>
</tr>
<tr>
<td>Ftgs:</td>
<td>FRP to match pipe</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All sizes</th>
<th>Valves:</th>
<th>FRP</th>
<th>Refer to Section 13119, Biofilter System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dampers:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Buried and Encased Pipe/Valves:

<table>
<thead>
<tr>
<th>All sizes</th>
<th>Pipe:</th>
<th>HDPE: Refer to Section 13119, Biofilter System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conn:</td>
<td>Flanged or plain end butt weld.</td>
<td></td>
</tr>
<tr>
<td>Ftgs:</td>
<td>HDPE to match pipe</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All sizes</th>
<th>Valves:</th>
<th>Butterfly: Same as exposed with extension stem and valve box. Coating in accordance with Section 09900, Painting.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

(The remainder of this page was left blank intentionally.)
3.10 SYSTEM - 24

Piping Symbol/Service: SW   Sanitary Waste

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.

Exposed Pipe/Valves:
- 6-inches to 12-inches
  - Pipe: Ductile AWWA C151. Refer to Section 15101, Ductile Iron Pipe.
  - Conn: Flanged or mechanical.
  - Valves: Plug Refer to Section 15112, Eccentric Plug Valves, Operators and Appurtenances

Buried and Encased Pipe/Valves:
- 12-inches and smaller
  - Pipe: Ductile: Same as exposed.

12-inches and smaller Valves: N/A.

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

++ END OF SECTION ++
SECTION 15051

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 Division 15, 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 15051, Buried Piping Installation, specifies the installation of all buried piping materials specified in Sections of Division 15, Mechanical. 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 01452, 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) Compaction test shall be taken at least every 2 feet of total lift and 10 feet lineally.

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) 5 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.
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:
   d. ASTM D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. ASTM D2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   g. ASTM D3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
   h. ASTM D4318, Method of Test for Liquid Limit of Soils.
   i. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
   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 D2321, Practice for Underground Installation of Flexible Thermoplastic Pipe.
   b. ASTM D2774, 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.
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.

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. 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 00700, General Conditions, and Section 00800, 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 01143, Coordination with OWNER'S Operations.
2. 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.

3. 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 02220, 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. 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.

<table>
<thead>
<tr>
<th>Sieve Sizes (Square Opening)</th>
<th>Percentage by Weight Passing Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Select Material Type B</td>
</tr>
<tr>
<td>1-1/2-inch</td>
<td>100</td>
</tr>
<tr>
<td>1-1/4-inch</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>30 – 70</td>
</tr>
<tr>
<td>No. 8</td>
<td>20 – 60</td>
</tr>
<tr>
<td>No. 30</td>
<td>10 – 40</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 12</td>
</tr>
</tbody>
</table>

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 or Pipe, and HDPE Duct or Pipe) 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 D698, 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 03300, Cast-In-Place Concrete, 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 D698 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 D698 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 15050, Piping Systems. Piping materials shall conform to detailed Specifications for each type of pipe and piping appurtenances specified in the applicable Sections of Division 15, Mechanical.

2.3 PIPING IDENTIFICATION

   A. Magnetic Tracer Tape Marking shall conform to the requirements specified in Section 15050, 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. 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. 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.
F. 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.

<table>
<thead>
<tr>
<th>Size of Pipe (I.D.) (Inches)</th>
<th>Maximum Width at Top of Pipe Greater than O.D. of Barrel</th>
<th>Minimum Width at Springline Each Side of Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 18</td>
<td>16 inches</td>
<td>6 inches</td>
</tr>
<tr>
<td>18 to 24 inclusive</td>
<td>19 inches</td>
<td>8 inches</td>
</tr>
<tr>
<td>27 to 39 inclusive</td>
<td>22 inches</td>
<td>9 inches</td>
</tr>
<tr>
<td>42 to 60 inclusive</td>
<td>1/2 of Pipe O.D.</td>
<td>12 inches</td>
</tr>
<tr>
<td>Over 60</td>
<td>36 inches</td>
<td>12 inches</td>
</tr>
</tbody>
</table>

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.

G. 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 granular bedding at least 4 inches thick or 1/2 the outside diameter of the pipe whichever is greater. The bedding material shall be placed at a uniform density with a minimum compaction density of 100% percent as determined by AASHTOT -99 and T-191 or ASTM D-2922 and D-3017. If required and approved by ENGINEER, depths may be revised. Remove all loose and unsuitable material from the trench bottom.

H. 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.
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.

I. 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 AASHTO T-99, Method A or B, and T-191 are used for density determination, MAG, Detail 190, will be used for rock correction.

J. 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 AASHTO T-99 and T-191 or ASTM D-2922 and D-3017.

K. Where pipe is laid in rock excavation, crushed stone as specified in Section 02318, Crushed Stone and Gravel, 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 AASHTO T-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, but in no case shall the earth cover be less than 36 inches for all piping, except drains.

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 no 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 feet 0 inch 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. FRP pipe.

2. Retain installation specialist at the site for a minimum of one 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:
      b. Fiberglass Reinforced Polymer Mortar Pipe: AWWA C950.

F. Polyethylene Encasement:
   1. Provide two layers of 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 15101, 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:

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Bolt Size (inches)</th>
<th>Range of Torque (ft-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5/8</td>
<td>45 to 60</td>
</tr>
<tr>
<td>4 to 24</td>
<td>3/4</td>
<td>75 to 90</td>
</tr>
<tr>
<td>30 to 36</td>
<td>1</td>
<td>100 to 120</td>
</tr>
<tr>
<td>42 to 48</td>
<td>1-1/4</td>
<td>120 to 150</td>
</tr>
</tbody>
</table>

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 15101, Ductile Iron Pipe.

2. Ductile Iron Push-On Joint Pipe:
   a. Comply with requirements of Section 15101, 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. 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. 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. Copper Tubing Joints:

a. Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.

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.

6. 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.

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 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown on the Drawings and specified.

B. Thrust restraint shall be accomplished by means of restrained pipe joints. Concrete thrust blocks shall be used only when specifically shown on the Drawings or as directed by the ENGINEER. Thrust restraints shall be designed for the axial thrust exerted by the test pressure for each piping system as specified in Section 15050, Piping Systems.

C. Restrained Pipe Joints:
   1. 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 American Lok-Ring, Ebba Iron, Inc., Series 1100 Megalug, U.S. Pipe TR Flex System, lugs, and tie rods, or other system approved by ENGINEER.
      b. Harnessed lengths for buried pipe shall be determined by the pipe manufacturer in accordance with the formula for determination of buried pipe harnessed lengths located at the end of this Section.

D. Concrete Thrust Blocks:
   1. Thrust blocks shall be constructed of Type 2 concrete.
   2. Blocks shall be placed against undisturbed soil as shown on Drawings or as directed by the ENGINEER. Concrete shall be placed so that pipe joints and fitting joints will be accessible for repair.
   3. Size of concrete thrust blocks shall be as shown on the Drawings, or as directed and approved by ENGINEER.
   4. Provide concrete thrust blocks on pressure piping at all changes in alignment of 15 degrees or more, at all tees, plugs and caps and where shown on the Drawings.

3.6 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 D2922 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:

<table>
<thead>
<tr>
<th>Material</th>
<th>Required Minimum Density-Percent Compaction (ASTM D698)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Base Course:</td>
<td></td>
</tr>
<tr>
<td>Below asphalt paving</td>
<td>100</td>
</tr>
<tr>
<td>Trench Backfill above pipe:</td>
<td>95</td>
</tr>
<tr>
<td>Granular Pipe Embedment Material</td>
<td>100</td>
</tr>
<tr>
<td>Sand Embedment Material:</td>
<td>95</td>
</tr>
</tbody>
</table>

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.

3.7 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. 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.

C. 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.

D. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density required.

3.8 PAVEMENT SUBBASE COURSE

A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.

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 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 by CONTRACTOR and disposed of in compliance with municipal, county, state, federal or other applicable regulations at no additional cost to OWNER.
3.10 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 01143, 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.

3.11 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 15050, 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 15050, 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 15050, Piping Systems.
   b. If a test pressure is not listed in Section 15050, Piping Systems, or if a hydrostatic test is required for piping not listed in Section 15050, 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 15050, 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.

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2 min. 50 sec.</td>
</tr>
<tr>
<td>8</td>
<td>3 min. 50 sec.</td>
</tr>
<tr>
<td>10</td>
<td>4 min. 45 sec.</td>
</tr>
<tr>
<td>12</td>
<td>5 min. 40 sec.</td>
</tr>
<tr>
<td>14</td>
<td>6 min. 40 sec.</td>
</tr>
<tr>
<td>16</td>
<td>7 min. 5 sec.</td>
</tr>
<tr>
<td>18</td>
<td>7 min. 35 sec.</td>
</tr>
<tr>
<td>20</td>
<td>9 min. 30 sec.</td>
</tr>
<tr>
<td>21</td>
<td>9 min. 55 sec.</td>
</tr>
<tr>
<td>24</td>
<td>11 min. 20 sec.</td>
</tr>
<tr>
<td>27</td>
<td>12 min. 45 sec.</td>
</tr>
</tbody>
</table>

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 15050, 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.

3.12 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.
3.13 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:
   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.
### 3.14 INSTALLATION OF DETECTABLE PIPE LOCATING TAPE

**A. Underground Pipe Locating Tape:**

1. Refer to paragraph 2.3.A of this Section, and Section 15050, 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:

\[
\text{Harnessed Length (L)} = \frac{T}{f \sum W}
\]

where:

- \( T = 1.25 \, PA \sin \Delta/2 \)
- \( T = \text{Thrust (lbs)} \)
- \( P = \text{Test Pressure (psi), refer to Section 15050, Piping Systems.} \)
- \( A = \text{Pipe Area (sq.in.)} \)
- \( \Delta = \text{Angle of Bend} \)
- \( f = \text{friction factor between soil and pipe} = 0.3^* \)
- \( \sum W = W_p + W_s + W_w \)
  - \( W_p = \text{weight pipe (pounds per linear foot-PLF)} \)
  - \( W_s = \text{weight soil (PLF)**} \)
  - \( W_w = \text{weight fluid (PLF)} \)

* 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.

+++ END OF SECTION +++
SECTION 15052

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. Cleaning and disinfecting.
      g. 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.
      h. 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.
      i. 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 15052, 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:
   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.

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 Steel Butt Welding Fittings.
   5. ANSI B 16.11, Forged Steel Fittings, Socket-Welding and Threaded.
   6. ANSI B 31.1, Power Piping.
   8. ANSI B 31.8, Gas Transmission and Distribution Piping Systems.
   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 C 651, Disinfecting Water Mains.
   14. AWWA M9, Concrete Pressure Pipe.
   15. AWWA M11, Steel Water Pipe Design and Installation.
   16. AWWA M23, PVC Piping.
   17. AWS D 1.1, Structural Welding Code.
   20. ASME Boiler and Pressure Vessel Code.
   22. NFPA 14, Standpipe and Hose Systems.
   25. NSF/ANSI 61, Drinking Water System Components Health Effects.
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 01600 requirements.

D. Record Drawings:
   1. Submit Record Drawings prior to the time of Substantial Completion.

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 15050, 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:

<table>
<thead>
<tr>
<th>Process Fluid</th>
<th>Compatible Materials of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferric Chloride</td>
<td>Buna, EPDM, Teflon, Viton</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>Teflon, Viton</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>Teflon, Hypalon, Polypropylene</td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td>Teflon, PVDF, Hypalon, Polypropylene</td>
</tr>
<tr>
<td>Polymer</td>
<td>Viton, Teflon</td>
</tr>
<tr>
<td>Methanol</td>
<td>Buna-N, Teflon</td>
</tr>
</tbody>
</table>

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. Manufacturer's Installation Specialist:
   1. Provide the services of a competent installation specialist of the pipe
      manufacturer when pipe installation commences, if CONTRACTOR is not
      experienced installing a particular type of pipe, for the following:
      a. FRP pipe.
   2. Retain installation specialist at the site for a minimum of one days or until
      competency of the pipe installation crew has been satisfactorily demonstrated.
C. 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. Protect and keep clean water pipe interiors, fittings and valves.
   6. 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.
   7. Cutting: Cut pipe from measurements taken at site, not from Drawings.
   8. 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.
   9. Provide a union downstream of each valve with screwed connections.
  10. Provide screwed or flanged unions at each piece of equipment, where shown on
      the Drawings, and where necessary to install or dismantle piping.
  11. Additional Requirements for FRP 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 15061, 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 degrees Fahrenheit.

D. 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:

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Bolt Size (inches)</th>
<th>Range of Torque (ft-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5/8</td>
<td>45 to 60</td>
</tr>
<tr>
<td>4 to 24</td>
<td>3/4</td>
<td>75 to 90</td>
</tr>
<tr>
<td>30 to 36</td>
<td>1</td>
<td>100 to 120</td>
</tr>
<tr>
<td>42 to 48</td>
<td>1-1/4</td>
<td>120 to 150</td>
</tr>
</tbody>
</table>

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. 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.

E. 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.

F. 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.
G. 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.

H. 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.

I. 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 01143, Coordination with OWNER'S Operations.
   2. Notify ENGINEER at least 48 hours prior to taking pipeline out of service.

J. 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 15050, Piping Systems.

C. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Restrain ductile iron mechanical joint pipe utilizing tie rods and clamps or proprietary restrained joint system conforming to the requirements of Section 15101, Ductile Iron Pipe.
      b. 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.

3.3 PAINTING

A. Field painting shall conform to the requirements of Section 09900, Painting.
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 15050, Piping Systems.
2. For piping not included in Section 15050, 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, Ductile Iron, 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 AND DISINFECTION

**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. If piping which requires disinfection has not been kept clean during storage or installation, swab each section individually with a five percent hypochlorite solution, to ensure clean piping.

**B. Disinfection:**
1. Disinfect all potable and finished water piping.
2. A suggested procedure for accomplishing 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 sweeping, 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 methods are acceptable to ENGINEER.
3. Water for initial flushing, testing and chlorination will be furnished by 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 laboratory report will be 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 required to provide complete disinfection.

7. After the required retention period, the heavily chlorinated water shall be flushed to approved drain location, unless otherwise directed by the ENGINEER.

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:
      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 ++
SECTION 15061

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.
   3. ASTM A575, Specification for Steel Bars, Carbon, Merchant Quality,
      M-Grades.

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 01332, 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 01651, Transportation and Handling of Materials and Equipment.

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 01661, Storage of Materials and Equipment.

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:

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Steel</th>
<th>Copper</th>
<th>Plastic</th>
<th>Cast/Ductile Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 to 3/4</td>
<td>5</td>
<td>6</td>
<td>Cont. 3</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>1-1/4</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>1-1/2</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>2-1/2</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>12 feet for pressure pipe</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>12 feet for pressure pipe</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>10 feet for soil pipe</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>10 feet for soil pipe</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>10 feet for soil pipe</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>

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 degrees Fahrenheit. 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 degrees Fahrenheit 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 \( \Delta L \) = pipe length change (in.)
   b. \( L \) = pipe length between anchors (in.)
   c. \( \Delta T = 100 \) (F)
   d. \( \alpha \) = 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 15120, Piping Specialties and Accessories.

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.
   4. Unistrut Corporation.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A575, 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.
   2. Concrete inserts shall be of the continuous type capable of supporting 1,200 pounds per foot.
   3. Product and Manufacturer: Provide one of the following:
      a. Unistrut Corporation.
      b. Elcan Metal Products.
      c. ITT Grinnell.
      d. B-Line.

C. Brackets:
   1. Brackets for wall mounting shall be MSS SP-58.

2.4 PAINTING

A. Clean and shop prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09900, Painting.

B. Field painting shall conform to the requirements of Section 09900, Painting.

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.
   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:

<table>
<thead>
<tr>
<th>Nominal Pipe (Inches)</th>
<th>Rod Diameter (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 and less</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2 to 3-1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>4</td>
<td>5/8</td>
</tr>
<tr>
<td>6</td>
<td>3/4</td>
</tr>
<tr>
<td>8 through 12</td>
<td>7/8</td>
</tr>
<tr>
<td>14 through 18</td>
<td>1</td>
</tr>
<tr>
<td>20 through 30</td>
<td>1-1/4</td>
</tr>
</tbody>
</table>

   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.

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 15101

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidental 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 15050, 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.

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.
   5. AWWA C150, Thickness Design of Ductile Iron Pipe.
   6. AWWA C151, Ductile Iron Pipe, Centrifugally Cast.
8. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
9. AWWA C606, Grooved and Shouldered Joints.
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).

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 15051, Buried Piping Installation, Section 15052, Exposed Piping Installation, and Section 15061, 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.

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 15050, 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.

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. If not shown on the Drawings, use Pressure Class 350.
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. 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) 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.
   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.
   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.

6. Coatings and Linings:
   a. Unless otherwise specified, pipe and fittings shall be lined with an epoxy lining material.
   b. 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 09900, Painting.
   c. 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 two layers of 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: Epoxy lining shall be provided. The material shall be an amine cured novolac 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 B117 Salt Spray (scribed panel): Results to equal 0.0 undercutting after two years.
      2) ASTM G95 Cathodic Disbondment 1.5 volts at 77°F: Results to equal no more than 0.5 mm undercutting after 30 days.
         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. Victaulic fittings can be lined with fusion bonded epoxy AkzoNobel Material Number 10109108.
C. Couplings:
   1. Refer to Section 15120, 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. 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 inches, Special Thickness Class 53; for sizes 60 inches through 64 inches, Pressure Class 350.
         3) 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.

3. 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.

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 09900, Painting.
   2. Field painting shall conform to the requirements of Section 09900, Painting.

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 15050, Piping Systems, and Section 15051, Buried Piping Installation.

B. For exposed piping installation and testing, refer to Section 15050, Piping Systems, and Section 15052, Exposed Piping Installation.

C. Testing
   1. General:
      a. The Contractor shall test pipelines for water tightness, including all fittings and connections to the pipelines. 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.

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, and valves shall be tested with the main, where practical.

f. The test section shall be slowly filled with water and all air shall be vented from the line. The rate of filling shall be as approved by the Superintendent of Wastewater 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.

2. Pressure Test:

a. Pipelines, 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 pipeline 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.

D. Polyethylene Encasement:
1. Encase all ductile iron pipe with two layers of 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  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 ++
SECTION 15105

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 15050, 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.

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.
   5. ASTM B68, Specification for Seamless Copper Tube, Bright Annealed.
10. ASTM B306, 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 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Certificates: Where specified or otherwise required by the ENGINEER submit test certificates. Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Potable Piping: Potable piping shall conform to the requirements of ASTM B88. 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 B302.

C. 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. Piping shall be assembled with joints as described in Specification Section 15050, Piping Systems.
   1. ANSI B16.22 for Wrought Copper and Copper Alloy Solder-Joint Pressure Fitting.

B. All joints shall conform to manufacturer's 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 15050, Piping Systems, and Section 15051, Buried Piping Installation, for installation, testing, and cleaning.

B. Refer to Section 15050, Piping Systems, and Section 15052, 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 15120, 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 15108

FIBERGLASS REINFORCED PLASTIC 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 fiberglass reinforced plastic (FRP) piping.
2. The extent of fiberglass reinforced plastic pipe is shown on the Drawings and as specified in Section 15050, Piping Systems.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Manufacturers of fiberglass reinforced plastic pipe and fittings shall have a minimum of five years of experience producing fiberglass reinforced plastic 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 D1330, Specification for Rubber-Sheet Gaskets.
5. ASTM D2310, Classification for Machine-Made Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube.
7. ASTM D2992, Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
10. ASTM D3754, Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
11. ASTM D3839, Practice for Underground Installation of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
14. AWWA C950, Glass-Fiber-Reinforced Thermosetting-Resin Pressure Pipe.

C. Shop Tests:
1. Manufacturer shall maintain a continuous quality control program and shall provide the ENGINEER with certified test reports.
2. Tests shall be witnessed by a Registered Professional Engineer or a member of ASTM, who may be an employee of the manufacturer. The Registered Professional Engineer shall seal and sign all test reports.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Details of construction, fabrication, and specifications for pipe laminate construction.
2. Details of piping system including location of supports, fittings, anchors, and all accessories necessary for piping system.
3. Pipe laying schedules.
4. Submit these with Shop Drawings required under Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. A sample piece of pipe approximately 1-foot long of each diameter, if requested by ENGINEER.

C. Test Reports: Submit reports for any tests required above with test specimens.

D. Certificates: Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Follow "Recommended Practices for Shipping and Installation of Reinforced Plastic Pipe, Duct and Tanks" of the Society of the Plastics Industry, Inc.
PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Fiberglass reinforced thermosetting plastic piping system shall be specifically designed, constructed, and installed for the service intended and shall comply with the following service conditions.

B. Service Conditions:
   1. Nominal Pipe Size: in. Per Drawings
   2. Reinforced Wall Thickness: in. Manufacturer to determine based on service conditions.
   3. Air Temperature: °F max. 120
   4. Ducting under pressure conditions: in. wc 10
   5. Ducting under vacuum conditions: in. wc 13
   6. air Flow: acfm 800
   7. Air Chemical Composition: Odorous Air from Lift Station
   8. Specific Gravity: 1.0

2.2 DETAILS OF CONSTRUCTION

A. Pipe shall be manufactured to meet the applicable requirements of ASTM D2996.

B. Product and Manufacturer: Provide one of the following:
   1. Daniel Company.
   2. NOV/Ameron Bondstrand.
   3. Or equal.

C. Products shall be of standard manufacture, conforming to applicable requirements of ASTM and as herein specified.

D. Fittings: Fittings such as elbows, laterals, tees, and reducers shall be of the same resin as and equal or superior in strength to the adjacent pipe section and shall have the same internal diameter as the adjacent pipe. Face to face flange dimensions shall conform to the standards of 150-psi ANSI fittings.

E. Fasteners: Furnish all bolts, nuts, washers and other fasteners required. Material of metallic fasteners shall be Type 316 stainless steel.
F. Gaskets: Gaskets shall be furnished by the piping manufacturer with suitable chemical resistance to the service environment. Gaskets shall be 1/8 inch minimum in thickness with a Shore Durometer hardness of 60 to 70.

G. Flanged Connections: Connections to expansion joints, valves, tanks or other equipment shall be flanged. Flanges shall be hand laid up to PS15-69 thickness, except that minimum thickness shall be 3/4 inch. Each flange face shall be machined flat, and a new corrosion barrier applied. Face shall be textured for use with full-face chlorobutyl gaskets, 1/8 inch minimum thickness. Flange drilling shall be ANSI B16.1 125 pounds. Boltholes shall be back spot-faced for a washer seat. Flange bolts shall be torqued to manufacturer's recommended values.

H. Guides, Anchors and Supports: Guides, anchors and supports shall be as shown on the Drawings and in accordance with manufacturer's recommendations. Provide saddle bands and FRP buildup. Support spacing shall not exceed six feet, unless otherwise shown on the Drawings.

I. Expansion Compensation: Have the pipe manufacturer review the piping layout shown on the Drawings including the number and position of expansion joints and supports. If recommended by the pipe manufacturer, and approved by ENGINEER, supply additional expansion joints, pipe supports and pipe anchors as required for the particular piping system proposed by the manufacturer.

2.4 MAINTENANCE TOOLS AND SPARE MATERIALS

A. Furnish and deliver the following tools and maintenance materials carefully boxed or packaged and plainly marked for recording:
   1. One set of special tools required to maintain and repair the piping.
   2. All materials in kit form to make or repair joints. Kits shall be in a number sufficient to repair 10 percent of the joints.
   3. Pipe and fittings equal to ten percent of the installed system.
   4. Names and addresses of all manufacturers of fiberglass reinforcements, resins, hardeners, and components used to repair and maintain fiberglass reinforced plastic piping system.

B. Store and safeguard tools and materials until completion of the Work, at which time they shall be inventoried, delivered, and placed in an area designated by OWNER.

2.5 MARKING FOR IDENTIFICATION

A. All pipe line materials shall be permanently marked with the following:
   1. Name or trademark of manufacturer.
   2. Pipe class and specification designation.
   3. Pipe size, grade, and type.
   4. Date and place of manufacture.
   5. Pipe schedule.
PART 3 - EXECUTION

3.1 INSTALLATION

A. For buried piping installation, refer to Section 15051, Buried Piping Installation.

B. For exposed piping installation, refer to Section 15052, Exposed Piping Installation.

++ END OF SECTION ++
SECTION 15112

ECCENTRIC PLUG 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 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 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 eccentric plug 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 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.4, Cast Iron Fittings.
   4. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
   6. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
11. ASTM A2472, Specification for Nickel-Copper Alloy Plate, Sheet and Strip.
12. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
15. AGMA Standards.
16. NEMA, National Electrical Manufacturer's Association.
18. City of Phoenix – Amendments to the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Comply with the requirements of Section 01332, 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. Cv values and headloss curves.
   11. Calculations:
       a. Sizing of operating mechanism with extension stems.
       b. Sizing of gear actuators.
       c. Sizing of anchor bolts.

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 01781, Operation and Maintenance Data.

C. 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.

D. 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. Buried eccentric plug 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.

6. Buried eccentric plug valves shall be provided with adjustable two piece valve boxes and provided with extension stems, operating nuts and covers, unless otherwise shown on the Drawings or specified. Extension stems shall terminate 12-inches below finished grade. An operating key shall also be provided.

7. All bolts, nuts and studs on or required to connect buried or submerged valves shall be 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 A307, Grade B; or ASTM A354.

11. Bolts and nuts shall have hexagon heads and nuts.

12. All materials of construction of the eccentric plug valves shall be suitable for the service identified in Section 15050, Piping Systems, and 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 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. Stenciled designations are acceptable for buried valves.

17. Buried or submerged service eccentric plug valves shall be provided with greased filled actuators with position indicators.

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 B16.1, Class 125.

2. Eccentric Plug Valves:
   a. Valves shall have a valve port area of a minimum 100 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, Class 125. Buried valves shall be provided with flange ends with mechanical joint adapters.
d. Valve bodies shall be of cast iron conforming to ASTM A126, 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 B127.

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 inches and smaller. Bearings shall be ASTM A743/A 43M 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. Buried or submerged service valves shall have a self adjusting, multi-V-ring type packing in a suitable sealed enclosure.

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 degrees Fahrenheit.

h. 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 inches and smaller for 175 psig differential pressure.
   d. Design the actuators to hold the valves in any intermediate position without creeping or vibrating.
   e. Provide a valve position indicator on each actuator. Provide stop-limiting devices for open and closed position.
   f. Provide an adjustable stop to adjust the seating pressure.
   g. Make packing accessible for adjustment without requiring the removal of actuator from the valve.
   h. The diameter ratio of the handwheel or the chainwheel and the gear sector shall be less than two.
   i. For buried or submerged valves, the gear actuator shall be grease-packed and designed to withstand submersion and be driptight in water to 20 feet submergence.
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. All actuator components between the input and the stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and an input torque of 300 foot-pounds for operating nuts when operating against the stops.

o. Materials of Construction:
   1) Housing: Cast Iron, ASTM A126, Class B.
   2) Gear Sector: Ductile Iron, ASTM A536.
   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.

p. Where lever wrench operated valves are required, each valve shall be furnished with its own lever wrench operator.

q. Valve packing adjustment on non-submerged valves shall be accessible without removing the actuator from the valve.

r. 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. Eccentric Plug Valves - Guarantee:

(The remainder of this page was left blank intentionally.)
WHEREAS

of (Address)

, Telephone:

Herein called the "Valve Manufacturer" has furnished eccentric plug valves on the following Project:

City of Phoenix
Lift Station 47
Civil & Electrical Improvements

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): ________________________________

(The remainder of this page was left blank intentionally.)
2.3 APPURTENANCES FOR EXPOSED VALVES

A. General:
   1. For valves located less than 5 feet-0 inch 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. 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.

2.4 APPURTENANCES FOR BURIED VALVES

A. Wrench Nuts:
   1. Provide wrench nuts on all buried valves of nominal 2-inch size conforming to
      AWWA C500.
   2. Arrow indicating direction of opening the valve shall be cast on the nut along
      with the word "OPEN".
   4. The nut shall be secured to the stem by mechanical means.

B. Extension Stems for Non-Rising Stem Valves and Quarter Turn Buried Valves:
   1. Provide extension stems to bring the operating nut to 12 inches below the valve
      box cover.
   2. Minimum Size and Material: Same as valve stem.
   4. Provide top nut and bottom coupling of ductile iron with pins and set screws of
      Type 316 stainless steel.

C. Valve Boxes:
   1. Valve boxes shall be as shown on the Drawings and as required.
   2. Type: Heavy-duty, suitable for highway loading, two piece telescopic, and
      adjustable. Lower section shall enclose operating nut and stuffing box and rest
      on bonnet.
   3. Material: Cast or ductile iron.
      TT-C-494.
   5. Marking: As required for service.
2.5 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 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

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.


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 09900, Painting.

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 09900, Painting.

D. Certify, in writing, that the shop primer and coating system is compatible with the finish coating system in accordance with Section 09900, Painting.

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.
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.

E. 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. Provide a flexible coupling next to a buried valve for ease of valve removal.

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.

++ END OF SECTION ++
SECTION 15114

CHECK 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 check 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 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 type of check 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. AGMA Standards.
2. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.4, Cast Iron Fittings.
9. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
13. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
14. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds.
16. AWWA C506, Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
17. AWWA C508, Swing Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
18. NEMA, National Electrical Manufacturer's Association.
19. Comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420 – References.

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 and installation drawings.
   5. Control characteristics of modulating valves.
   6. Certificates of compliance with AWWA Standards, where applicable.
   7. 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.
   8. Power and control wiring diagrams, including terminals numbers.
   9. Complete manufacturer's nameplate data of valves.
  10. Special tools list.
  11. Cv Values and headloss curves.

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 01781, 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 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. 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.
   3. All bolts, nuts and studs on/or required to connect buried or submerged valves shall be Type 316 stainless steel.
   4. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
   5. 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.
   6. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A307, Grade B; or ASTM A354.
   7. Bolts and nuts shall have hexagon heads and nuts.
   8. Gasket material and installation shall conform to manufacturer's recommendations.
9. 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.

10. All materials of construction of the valves shall be suitable for the applications as shown on the Drawings.

11. Protect wetted parts from galvanic corrosion due to contact of two different metals.

B. Check Valves - Liquid Service:
   1. General:
      a. Check valves shall absolutely prevent the return of water back through the valve when the upstream pressure decreases below the downstream pressure. The valve shall be tight seating.

C. 3-Inch Diameter and Larger - Air Cushioned Type:
   1. Provide valves conforming to AWWA C508-09 and as specified herein.
   2. Valve shall be a counterweighted, rubber seated swing check valve with external air cushion chamber. Valve shall permit flow in one direction only and close tightly, without slamming, when its discharge pressure exceeds its inlet pressure.
   3. Valve shall have a hinge shaft located completely above the waterway, and shall be Type 316 stainless steel with the disc-arm and counterweight arm keyed thereon. Hinge shaft packing gland shall be of adjustable packing gland design employing a compression type packing. Simple O-ring shaft seals will not be accepted.
   4. Valve shall be tight seating when closed, and provide a full equivalent pipe area when open fully. Seating shall be by a resilient field replacement ring on the valve disc contacting a Type 316 stainless steel seat ring in the valve body.
   5. Provide an external adjustable counterweight to initiate valve closure, and an air cushion chamber mounted externally to dampen valve closure due to counterweight action. The air cushion chamber shall be of all bronze or bronze and stainless steel, and shall be field adjustable.
   6. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows for various valve components:
      a. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
      b. Disc Arm: Ductile iron.
      c. Hinge Shaft: Type 316 stainless steel.
      d. Hinge Shaft Bushings: Bronze.
      e. Shaft End Plate: Type 316 stainless steel.
      f. Body Seat: Type 316 stainless steel.
      g. Follower ring for Rubber Seat on Disc: Type 316 stainless steel.
      h. Disc Center Pin Assembly: Type 316 stainless steel.
i. Air Cushion Chamber:
   1) Chamber and Plunger: Bronze.
   2) Linkages and Pins: Type 316 stainless steel.
   3) Air Check Valve and Tubing: Brass.

j. All Rubber Items:
   1) Up to 180 degrees Fahrenheit Fluid Temperature: Buna-N, or other synthetic rubber suitable for the application.
   2) Greater than 180 degrees Fahrenheit Fluid Temperature: Viton, or other synthetic rubber suitable for the application.

k. All internal and external bolting and other hardware including pins, set screws, studs, bolts, nuts and washers: Type 316 stainless steel.


7. Testing:
   a. Test all valves in the shop in conformance with AWWA C508.

8. Shop Painting:
   a. Interior metal surfaces of the valve, except finished or bearing surfaces, shall be shop painted with two coats of an approved epoxy coating applied in accordance with the manufacturer's recommendations.
   b. Exterior surfaces of the valve shall be shop painted as specified hereinafter under Article 2.2, below.

9. Product and Manufacturer: Provide one of the following:
   a. DeZurik Corporation
   b. G.A. Industries.
   c. Pratt/CCNE
   d. Or equal.

2.2 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09900, 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 09900, Painting.

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 09900, Painting.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with manufacturer's instructions and recommendations.

B. 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.

++ END OF SECTION ++
SECTION 15119

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.
4. ANSI B16.4, Cast Iron Fittings.
5. ANSI B40.1, Gauges-Pressure Indicating Dial Type-Elastic Element.
9. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
13. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
14. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds.
15. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedulers 40, 80 and 120.
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 C508, Swing Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
23. AWWA C509, Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewerage Systems.
24. AWWA C512 Air-Release, Air/Vacuum and Combination Air Valves for Water Works Service
25. AGMA Standards.
27. NEMA, National Electrical Manufacturer's Association.

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 01781, 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.

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 A307, Grade B; or ASTM A354.

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.

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. 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 degrees Fahrenheit temperature.
   4. End Connections: Solder end welded to hose and braid ends.
   5. Product and Manufacturer: Provide one of the following:
      a. Flexonics Incorporated.
      b. Anaconda Metal Hose Division, Anamet Incorporated.
      c. Or equal.

D. Quick Coupler Connections:
   1. Type: Cam arms lock into adaptor groove.
   2. Materials: Adaptor and Coupler:
      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.
   5. Product and Manufacturer: Provide one of the following:
      a. Dixon Valve & Coupling.
      b. Or equal.

E. Hydrants:
   1. Post:
      a. Post hydrants system shall be of the non-freezing exposed head type.
      b. Provide post hydrants with a concrete protective base as specified.
      c. Depth of bury shall be a minimum of 36-inches.
      d. Provide each post hydrant on a non-potable water system with an engraved lamacoid warning sign rigidly attached to or at the hydrant. The sign shall be approximately 5-inches by 2-inches with red letters on a white background and shall read "NON-POTABLE WATER - DO NOT DRINK."
      e. Hydrants shall open counter-clockwise.
      f. Product and Manufacturer: Provide one of the following:
         1) Zurn.
         2) J.R. Smith.
         3) Or equal.

F. Combination Air Valves:
   1. All valves listed below shall meet AWWA C512, latest edition, Standard for Combination Air Valves for Water Works Service.
2. Combination Air Valves:
   a. Purpose: Combination valves or the air release and vacuum breaking valve allows large volumes of air to enter through the large diameter vacuum breaking valve and small amounts of air to release through the air release valve.
   b. Operation: Float actuated valve with large orifice exhausts or admits air from the system, with small venting orifice discharges accumulated air or vapor to atmosphere with the system under pressure.
   c. Design Conditions for upstream of check valve:
      1) Air Release Orifice Size: 0.024 square inch.
      2) Air Inlet Orifice Size: 3 inches.
      3) Non-slam Discharge Throttling Attachment: 0.314 inch.
   d. Design Conditions for downstream of check valve:
      1) Air Release Orifice Size: 0.024 square inch.
      2) Air Inlet Orifice Size: 3 inches.
      3) Non-slam Discharge Throttling Attachment: 0.314 inch.
   e. Construction:
      1) Body Configuration: Single Body.
      2) Body, Cover: Type 316 Stainless Steel ASTM A240.
      3) Float: Type 316 Stainless Steel ASTM A240.
      4) O-Ring: BUNA-N.
      5) Trim: Type 316 Stainless Steel ASTM A240.
      6) Outlet Size/Conn: Inlet shall be 3 inches, (threaded, flanged) unless otherwise shown on the Drawings.
      7) Outlet Size/Conn: Size and connection (threaded, flanged, hooded) as shown on drawings.
3. Product and Manufacturer: Provide one of the following:
   a. ARI D-023 NS.

2.2 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09900, 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 09900, 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 09900, 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.

++ END OF SECTION ++
SECTION 15120

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 01330, Submittals, and Section 01332, Shop Drawing Procedures.
   2. Certificates of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-4-119, in accordance with Section 01600 requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, 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 15050, 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.

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Number of Bolts</th>
<th>Bolt Diameter (Inches)</th>
<th>At (Degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
<td>5/8</td>
<td>180</td>
</tr>
<tr>
<td>6-8</td>
<td>2</td>
<td>3/4</td>
<td>180</td>
</tr>
<tr>
<td>10-12</td>
<td>2</td>
<td>7/8</td>
<td>180 or 250</td>
</tr>
<tr>
<td>14-20</td>
<td>4</td>
<td>1</td>
<td>190</td>
</tr>
<tr>
<td>24-48</td>
<td>4</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>54</td>
<td>4</td>
<td>1</td>
<td>250</td>
</tr>
<tr>
<td>60</td>
<td>4</td>
<td>1-1/4</td>
<td>90</td>
</tr>
</tbody>
</table>

   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) Type 511 or 400, as manufactured by Rockwell International.
      3) Series 411, as manufactured by Smith-Blair, Inc.
      3) Or equal.
CITY OF PHOENIX: Water Services Department  
PROJECT NAME: LIFT STATION 47 CIVIL & ELECTRICAL IMPROVEMENTS  
PROJECT NUMBER: WS90400079

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 degree Fahrenheit 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 15050, 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 pipelines shall conform to the requirements of Section 15050, Piping Systems.  
6) Harnessing shall conform to the details shown on the Drawings.  
g. Product and Manufacturer: Provide one of the following:  
1) Style 127, as manufactured by Dresser Industries.  
2) Type FLA501, as manufactured by Rockwell International.  
3) Series 912 or 913, as manufactured by Smith-Blair, Inc.  
4) Or 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 degrees Fahrenheit.
   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.

C. 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.

D. Materials or products which 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 01420 – References.

2.2 PAINTING

A. Clean and shop prime and shop finish coat ferrous metal surfaces of equipment in accordance with the requirements of Section 09900, 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 09900, 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 15141

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:
      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.
   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.
   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 A120).
16. ANSI H 23.1, Seamless Copper Water Tube, (ASTM B88).
18. ASTM A53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless Pipe.
20. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
23. ASTM B813, Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
25. ASTM D2000, Classification System for Rubber Products in Automotive Applications.
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.

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:

1.4 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.


4. Certificate of Compliance with NSF/ANSI 61 & 372, and AAC R18-4-119, in accordance with Section 01600 Requirements.

B. Record Drawings: Provide as specified in Section 01782, Record Documents.

C. Operation and Maintenance Manuals:
   1. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, 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 day's 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 15051, 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:
      b. Type: K or L.
2. Fittings:

3. Joints:
   a. Sweat:
      1) Solder Metal: ASTM B32.
      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.

4. Unions:
   b. Material: Bronze.
   c. Rating: 250 pound W.O.G.

B. Ductile Iron Pipe:
   3. Joints:
      a. Mechanical Joint (Underground):
      b. Grooved Joints (Exposed):
         1) Reference: ANSI B16.1, Class 125 or Class 250, as required.
      c. Flanged Joints (Exposed):
         1) Reference: ANSI B16.1, Class 125 or Class 250, as required.
      d. Provide a flange by mechanical joint adapter at all underground connections.

C. 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:
2.2 VALVES

A. Bronze Body Globe Valves:
   1. Type: Composition disc, union bonnet.
   3. Rating: 150 lb. SWP.
   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.
   3. Rating: 150 lb. SWP.
   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.
   3. Rating: 150 lb. SWP.
   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:
      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 B62.
      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 A126B.
      b. Pressure Rating: 125 psi steam.
      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.
   3. Rating: 125 lb. SWP.
   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.
   3. Rating: 125 lb. SWP.
   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. Wall Hydrants:
   1. Box-Type Hose Connection, Non-Freeze Type:
      a. Type: Anti-siphon non-freeze wall hydrant.
      b. Materials:
         1) Casing: Bronze with statuary bronze finish.
         2) Vacuum Breaker: Integral.
         3) Threads: Standard 3/4-inch hose thread outlet.
         4) Wall Clamp: Adjustable with set screw.
         5) Key: Removable tee handle type.
      c. Connection: 3/4-inch sweat end inlet and 3/4-inch hose thread outlet, universal type.
      d. Product and Manufacturer: Provide one of the following:
         1) Jay R. Smith, Fig. No. 5609-SE.
         2) Zurn Industries, Fig. No. Z-1300.
         3) Or equal.

C. Water Hammer Arresters:
   1. Materials:
   2. Connection: Male NPT thread.
5. Product and Manufacturer: Provide one of the following:
   b. Shoktrol by Zurn Industries.
   c. Or equal.

D. 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.

E. 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.

F. 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.

G. Thermometers:
1. Range: 30°F to 240°F temperature range in maximum of 2°F increments.
2. Type: Adjustable Angle Column Type Thermometer.
   a. Construction:
      1) Scales and Lens: 9-inch high satin finish aluminum scales, black numerals, front red reading mercury tubes.
      2) Wells: Insertion well with brass separable sockets.
      3) Neck: 2-1/2-inch extension neck.
      4) Window: Glass or clear acrylic plastic.
3. Type: Direct mounted, adjustable angle, dial type thermometer.  
   a. Construction:  
      1) 4-1/2-inch diameter cast aluminum with black finish.  
      2) Ring: Chrome plated close type.  
      3) Dial: White face with black numerals and graduations.  
      4) Window: Glass or clear acrylic plastic.  
      5) Pointer: Stainless steel, black finish, red tip, adjustable.  
      6) Wells: Insertion wells with brass separable socket.  
      8) Connection: Bottom connection.  

4. Product and Manufacturer: Provide one of the following:  
   a. Weksler Instrument Co.  
   b. H.O. Trerice Co.  
   c. Or equal.  

H. Pressure Gages:  
   1. Reference Division 17000, Specification 17052.  

I. 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.  
      e. Screws: Stainless steel.  
   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:  
      b. Hersey Products, Aergap Model FRP-II.  
      c. Febco, Model 825Y.  
      e. Or equal.
J. Backflow Preventers: 2-1/2-Inches and Larger:
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 or cast iron.
   b. Valve Discs: Neoprene.
   c. Diaphragm: Neoprene coated cotton duck.
4. End Connections: Screwed or flanged.
5. Accessories:
   a. Air gap drain funnel with threaded outlet and vent below furnished by manufacturer.
   b. Strainer with blowoff on inlet.
   c. O.S. and Y gate valves on inlet and outlet.
   d. Reduced pressure principle backflow preventer test kit for each unit furnished with carrying case, provided in molded plastic carrying case with foam inserts.
6. Product and Manufacturer: Provide one of the following:
   a. Hersey Products, Model 6CM.
   b. Febco, Model 825.
   d. Or equal.

K. Water Meter:
1. Type: Magnetic Drive, disk water meter.
2. Materials:
   a. Body: Bronze.
   b. Register: Brass.
   c. Gear Train: Self lubricating celcon plastic.
5. Product and Manufacturers: Provide one of the following:
   a. Hersey Products Inc., Model MHD.
   c. Or equal.

L. 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.


e. Working Pressure: 150 psi.


g. Product and Manufacturer: Provide one of the following:
   1) Watts Regulator Co., No. 800.
   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.


   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.
      3) Febco, Model 710/715 as required.
      4) Or equal.

M. Emergency Shower and Eyewash Stations:
   1. Emergency Shower (Laboratory): ES:LAB:
      a. Materials:
         1) Shower Head: Polished chrome plated brass flush to ceiling.
2) Valve: Ball type, stay open with chrome plated, stainless steel rigid pull rod with handle length as required for ceiling height.
3) Supply: 1-inch IPS horizontal.
4) Ceiling Support: Provide hanger anchored to concrete deck above for support at elbow.

b. Product and Manufacturer: Provide one of the following:
   1) Haws Drinking Faucet Co., Model 8169.
   2) Speakman Co., Model SE-236-PR.
   3) Or equal.

2. Eye Wash (Laboratory): EW:LAB:
   a. Materials:
      1) Heads: Twin chrome plated brass, soft flow.
      2) Swivel Joint: Chrome plated.
      3) Valve: Stay-open chrome plated ball valve, push type.
      4) Exposed piping, chrome plated.
   b. Product and Manufacturer: Provide one of the following:
      1) Haws Drinking Faucet Co., Model 7612.
      2) Speakman Co., Model SE-571.
      3) Or equal.

3. Emergency Shower and Eyewash (Corrosion Resistant): ESE-1:
   a. Type: Free standing corrosion resistant emergency shower and eyewash station.
   b. Materials:
      1) Shower: 9-inch diameter cycolac plastic shower head with 1-1/2-inch stay-open stainless steel ball valve and 24-inch rigid pull rod.
      2) Eye/Face-Wash: Cycolac bowl with twin Buna-N covered ABS heads and stainless steel ball valve, stay open type.
      3) Pipe: All PVC parts shall be Schedule 80, painted safety yellow.
      4) Supply: 1-1/4 inch PVC.
   c. Product and Manufacturer: Provide one of the following:
      1) Haws Drinking Faucet Co.
      2) Speakman Co., Model.
      3) Or equal.

4. Flow Switches, Audible and Visible Alarms:
   a. Type: Single pole, double throw, NEMA 4X, UL listed paddle type flow switch. Contacts to be rated for 5 amps at 120 volts.
   b. Flow switches shall be furnished by emergency shower and eyewash manufacturer at each shower and/or eyewash station. Shower flow switch shall be rated for 25 to 30 gpm flow and eyewash flow switch shall be rated for 0.3 to 3 gpm flow.
   c. Flow switches shall sense flow for showers and eyewashes. Flow switches shall be full line size so as not restrict water flow in order to detect flow. Provide separate flow switch for shower and eyewash, as required at each emergency shower and eyewash station.
d. Visible alarm shall be an amber flashing light, NEMA 4X, UL listed.
e. Audible alarm shall be an intermittent signal rated at 85 db at ten feet, NEMA 4X.
f. Each emergency shower station shall be furnished with a shower and eyewash test kit.
g. Product and Manufacturer: Provide one of the following:
   1) Haws Drinking Faucet Co. Model 9001.
   2) Speakman Co., Model AL-2-FLW (FS6W).
   3) Or equal.

5. Safety Valve Lockout with Padlock:
a. Heavy duty plastic, dielectric and chemical resistant valve lock.
b. Padlock with unique serial number, hardened steel shackle, two brass keys with matching serial numbers for each padlock.
c. Product and Manufacturer: Provide one of the following:
   1) Akron, Safety Products, Inc.
   2) Brady USA, Inc.
   3) Or equal.

6. Anti-Scald Valves:
a. Anti-scald valve provides scald protection and bleeds valve whenever internal temperature rises above 100°F and closes when line temperature drops to 85°F.
b. Product and Manufacturer: Provide one of the following:
   2) Speakman Co.
   3) Or equal.

N. Aquastats:
1. Type: Immersion type for regulating water temperature in hot water piping, tempered water piping, or hot water storage tanks.
2. Electrical Rating: 120 volts.
3. Setpoint Range:
   a. Domestic Hot Water: Make contacts on temperature drop below 112°F, break contacts on temperature rise above 120°F.
   b. Tempered Water: Make contacts on temperature drop below 65°F, break contacts on temperature rise above 73°F.
4. Adjustment: Adjustable setpoint through knob on cover.
5. Differential: Adjustable 3°F to 10°F.
6. Accessories: Provide immersion well.
7. Product and Manufacturer: Provide one of the following:
   a. Honeywell.
b. Johnson Controls.
c. Or equal.
O. Hot Water Temperature Maintenance Heat Tracing System:
   1. General: Furnish and install a complete UL Listed system of heaters and components approved and designed specifically for maintaining hot water temperature of 120°F. Hot water lines from hot water heater(s) to plumbing fixtures and as shown on Drawings, shall be electrically traced with self limiting heaters. Manufacturer shall assist in selecting the correct tracer and develop bill of materials. All connections and equipment shall be moisture-proof.
   2. The heater cable assembly shall consist of two 14 A.G. parallel nickel-plated copper bus wires imbedded in a self regulating core and covered in a cross-linked polyolefin insulating jacket. The heater assembly shall be covered with tinned copper metallic braid and an outer jacket of cross-linked polyolefin insulation, nominally of 40 mil thickness, and color coded for easy identification.
   3. The cable shall be rated for 208 volt operation.
   4. Pipe and heat trace shall be insulated as specified in Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.
   5. Provide all splice power-to-tracing connectors, thermostats, end terminations, straps, ground fault circuit breakers, junction boxes, etc as required.
   6. Product and Manufacturer: Provide one of the following:
       a. Thermon Manufacturing Co., Type HSX 2100.
       b. Or equal.

P. 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.
   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.

Q. Hose Nozzles:
   1. Materials:
      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.

R. 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.
   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.

S. Quick Coupler Connections:
   1. Type: Cam arms lock into adaptor groove.
   2. Materials: Adaptor and Coupler:
      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.
   5. Product and Manufacturer: Provide one of the following:
      b. Or equal.

T. Trap Primer Valve:
   1. Construction:
      b. Seals: O-ring 40°F to 450°F.
      c. Inlet and Outlet Size: 1/2-inch.
      d. Integral backflow preventer.
      e. Provide multiple outlet distribution unit, as required.
      g. Accessories: Floor drain trap primer distribution unit.
   2. Product and Manufacturer: Provide one of the following:
      a. Precision Plumbing Products.
      b. Or equal.
U. Trap Primer Valve:
   1. Type: Automatic trap priming assembly with timer, solenoid valve and air-gap device to automatically prime traps at set time intervals regardless of trap primer device location.
   2. Description: An electronically activated trap priming device. Primer functions at a pre-selected time, delivering water across an air gap funnel.
   3. Construction:
      b. Seals: O-ring 40°F to 450°F.
      c. Inlet and Outlet Size: 1/2-inch.
      d. Air gap device.
      e. Solenoid valve 115VAC, 6.3 watts, 60 Hz, Normally Closed.
      f. Provide multiple outlet distribution unit as required.
      h. Accessories: Floor drain trap primer distribution unit, a timer set to operate for six seconds every 24 hours.
   4. Product and Manufacturer: Provide one of the following:
      a. Precision Plumbing Products, Solo-Prime Electronic Trap Priming Assembly Model SP-500-115V.
      b. Or equal.

V. Janitor's Sink:
   1. Type: Enameled cast iron service sink, wall hanger, plain back, drilled for faucet through back.
   2. Accessories:
      a. Rim Guard:
         1) Product and Manufacturer: Provide one of the following:
            a) American Standard, Fig. No. 8379.026.
            b) Eljer, Fig. No. 805-0160.
            c) Or equal.
      b. Trap Standard:
         1) Product and Manufacturer: Provide one of the following:
            a) American Standard, Fig. No. 7798.176.
            b) Eljer, Fig. No. 804-1060.
            c) Or equal.
      c. Faucet:
         1) Product and Manufacturer: Provide one of the following:
            a) American Standard, Fig. No. 8344.111.
            b) Eljer, Fig. No. 749-1200.
            c) Or equal.
         2) Description: Exposed service sink faucet with vacuum breaker, integral stops, lever or four arm handles, spout with pail hook and hose end, top single brace, 1/2-inch I.P.S. female couplings and renewable seats.
3. Product and Manufacturer: Provide one of the following:
   a. American Standard, Fig. No. 7695.08.
   b. Eljer, Fig. No. 242-0150.
   c. 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.

H. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this Section shall comply with NSF/ANSI 61 & 372, and AAC R18-4-119.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of piping shall be in accordance with Section 15143, 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. All thermometers shall be legible from a standing position on the floor.

K. 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.

L. Provide automatic air vents at high points of hot water lines and where shown on the Drawings.

M. Provide valved blow-off connections for each strainer.

N. Remove each fine mesh start-up strainer screen and replace with final stainless steel strainer screen after 30 days of operating time.

O. Conform to applicable requirements in Section 15143, Installation of Plumbing Piping.

P. Provide shutoff valves to each piece of equipment furnished.
Q. 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 15142, Disinfection, Plumbing.

3.3 FIELD QUALITY CONTROL

A. Tests: Pressure test all systems in conformance with Section 15050, Piping Systems, and Section 15144, 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 15143

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:
   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.

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.

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.

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.
   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 ++
SECTION 15145

PIPE SLEEVES - PLUMBING

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 pipe sleeves, other wall pieces and escutcheons to the limits shown on the Drawings.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work, which is related to this Section.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. AWWA C100, Cast-Iron Pressure Fittings.
   3. AWWA C106 (ANSI A21.6), Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.
   4. AWWA C110 (ANSI A21.10), Gray-Iron and Ductile-Iron Fittings, 2 in. through 48 in., for Water and Other Liquids.
   7. AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on all wall and floor pipe, pipe sleeves and mechanical seals. Submit and coordinate these with Shop Drawings required for all piping systems.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe Sleeves:
   1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown on the Drawings.
   2. Copper Pipe: Use standard weight galvanized steel pipe with mechanical link seals as spacers, unless otherwise shown on the Drawings.
   3. Size sleeves to provide annular space required to accommodate mechanical link.

B. Cast Wall Sleeves:
   1. Material: Cast iron furnished with integral wall collar.
   2. Dimensions: As required for mechanical joint to pass through sleeve. Length as required.

C. Link Seals: Provide link type mechanical seals with adjusting bolts suitable for 20 psi working pressure where shown on the Drawings or required.
   1. Materials: Mechanical seals through non-fire rated walls or floors:
      a. Pressure Plate: Glass reinforced nylon plastic.
      c. Sealing Element: EPDM rubber.
   2. Materials: Mechanical seals through fire rated walls or floors; two independent mechanical seal assemblies required for each penetration:
      a. Pressure Plate: Low carbon steel, zinc galvanized plated.
      b. Bolt and Nut: Low carbon steel zinc galvanized.
      c. Sealing Element: Silicone rubber.
      d. Three-hour fire rating.
   3. Product and Manufacturer: Provide one of the following:
      a. Thunderline Corporation.
      b. Calpico, Incorporated.
      c. Or equal.

D. Wall, Floor and Ceiling Escutcheon Plates:
   1. Bare pipes passing through walls, floors and ceilings in any room: Provide escutcheon plates of cast brass or stamped steel, chrome plated, hinged with setscrews.
   2. Insulated pipes passing through walls, floors and ceilings in finished rooms: Provide plated escutcheon plates of stamped steel or cast brass, chrome plated, hinged with setscrews.
   3. Product and Manufacturer: Provide one of the following:
      b. Pegasus Manufacturing Incorporated.
      c. Or equal.
E. Exterior Walls or Floors: Below grade:
   1. Type: Thermoplastic sleeve for use in new construction where sleeves are exposed to liquid or on exterior walls or floors exposed to backfill only.
   2. Integral reinforcing ribs, anchor and waterstop collar textured surface for adhesion to concrete.
   3. Buried pipe sleeves shall have mechanical seals at each end.
   4. Product and Manufacturer: Provide one of the following:
      a. Thunderline Corporation.
      b. Calpico, Incorporated.
      c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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 finished areas shall extend a maximum of 1/4-inch above finished floor.
   3. Anchor sleeves to concrete and masonry walls as shown on the Drawings or otherwise approved by ENGINEER.
   4. Sleeves through walls shall be flush with wall face.
   5. Caulk and seal annular space between pipe and sleeve.
   6. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
   7. All vertical pipes through sleeves shall be installed with Link Seal "Pyro-Pacs" to maintain three-hour fire rating between the two fire areas.
   8. Size Sleeves to provide annular space as recommended by the mechanical seal manufacturer and as follows:

<table>
<thead>
<tr>
<th>Pipe Size (Inches)</th>
<th>Sleeve ID Minus Pipe or Insulation OD (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2</td>
<td>1/2 to 3/4</td>
</tr>
<tr>
<td>2 to 4</td>
<td>3/4 to 1-1/4</td>
</tr>
<tr>
<td>6 to 12</td>
<td>1-1/4 to 2</td>
</tr>
</tbody>
</table>

   9. For mechanical link seals, size sleeves to provide space required to suit link type seals provided.
   10. Seal annular spaces between pipe and sleeve, material and installation shall be as specified in Section 07920, Caulking and Sealants.
11. Do not install sleeves and pipes through structural members, unless specifically required due to coordination or obstructions, each sleeve condition shall be submitted for approval.
12. Buried pipe sleeves shall have mechanical seals at each end.

++ END OF SECTION ++
SECTION 15151

WASTE AND VENT PIPING 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 a complete waste and vent piping system including all floor drains, equipment and all soil, waste, drain and vent piping to the limits 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. Requirements of Regulatory Agencies:
   1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
   2. Permits: Obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ANSI A21.6, Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.
   4. ANSI A21.51, Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
   5. ANSI A112.5.1, Cast Iron Soil Pipe and Fittings.
   7. ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless Steel.
16. ASTM F441, Specification for Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe, Schedules 40 and 80.
18. CISPI HSN, Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturers literature, specifications, and engineering data including, dimensions, size and material of the following:
      a. Piping and fittings.
      b. Floor and equipment drains.
      c. Floor and wall cleanouts.
   2. Drawings on a 1/4-inch scale showing materials and dimensions of the complete waste and vent piping system, in plan and in section.

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 the 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 Acceptance of the Contract and prior to final payment.

1.4 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 piping installed under this Section shall conform to Section 15051, Buried Piping Installation.

PART 2 - PRODUCTS

2.1 PIPING

A. Cast Iron Soil Pipe and Fittings:
   2. Weight: Service Weight.
   3. Joints:
      a. Compression:
         1) Gasket: Neoprene Rubber, ASTM C564, CISPI HSN.
         2) Lubricant: As recommended by pipe manufacturer.

B. Steel Pipe and Fittings:
   1. Pipe: ANSI B125.2.
   2. Weight: Schedule 40.
   3. Finish: Galvanized.
   4. Fittings: ANSI B16.12 recessed drainage pattern galvanized cast-iron, threaded so as to allow 1/8-inch or 1/4-inch per foot grade, as required.

C. Hubless Cast Iron:

D. Chlorinated Polyvinyl Chloride Pipe and Fittings:
   1. Pipe: ASTM D1784 and ASTM F441, Class 23447-B.
   2. Weight: Schedule 80.
   4. Joints:
      a. Solvent weld with manufactures recommended solvents.

E. High Silicon Cast Iron Pipe:
   1. Silicon Content: 14.5 percent.
   2. Weight: 0.255 lbs. per cubic inch.
   3. Melting Point: 2,300°F.
   5. Tensile Strength (1/2-inch diameter): 20,000 psi.
   6. Joints: Hub and spigot with acid, resistant packing followed by lead.
   7. Fittings: Same material as pipe.
2.2 DRAINS AND CLEANOUTS

A. Drains and Cleanouts:
   1. Floor Drain and Shower Drain: (FD-1).
      a. Materials:
         1) Body: Enameled cast iron.
         2) Collar: Cast iron, reversible, threaded for strainer heads, enamel coated.
         3) Strainer Head: Square 8-inch by 8-inch nickel bronze grate with bronze body, heel proof grate, and vandal proof screws.
      b. Outlet Connection: Bottom outlet, caulk or no-hub, as required.
      c. Trap primer connection on body with thread to solder adapter, as required.
      d. Product and Manufacturer: Provide one of the following:
         1) Jay R. Smith.
         2) Zurn Industries.
         3) Or equal.

B. Cleanouts:
   1. Cleanout Deck Plates (Finished Areas) FCO-1:
      a. Materials: Cast iron body and adjustable nickel bronze top.
      b. Outlet Connection: Standard spigot.
      c. Accessories:
         1) Square nickel bronze top.
         2) Cast bronze taper thread plug.
      d. Product and Manufacturer: Provide one of the following:
         1) Jay R. Smith.
         2) Zurn Industries.
         3) Or equal.

   2. Cleanout Deck Plate (Traffic Areas) FCO-2:
      a. Materials: Cast iron body, flanged housing, cast iron cover with fitting device.
      b. Outlet Connection: Caulk outlet.
      c. Product and Manufacturer: Provide one of the following:
         1) Jay R. Smith.
         2) Zurn Industries.
         3) Or equal.

   3. Wall Cleanout Plate:
      b. Accessories:
         1) Stainless steel round shallow wall plate.
         2) Cast iron caulked ferrule.
      c. Product and Manufacturer: Provide one of the following:
         1) Jay R. Smith.
         2) Zurn Industries.
         3) Or equal.
C. Trap Primers:
   1. Type: Automatic floor drain trap primer valve.
   2. Connections: 1/2-inch inlet and 1/2-inch outlet.
   3. Accessories:
      a. Distribution units.
      b. Vacuum breaker.
   4. Product and Manufacturer: Provide one of the following:
      a. Precision Plumbing Products, Inc., Fig. PO-500.
      b. Or equal.

2.3 MATERIAL SELECTION

   A. All exposed gravity sanitary waste and vent piping run within the interior of a
      building shall be no-hub cast iron. Concealed gravity waste and vent piping lines
      may be steel or hubless cast iron. Provide adapters, as required.

   B. All gravity sanitary waste and vent piping located in concrete slabs or underground
      to exterior limits as shown on the Drawings shall be service weight cast iron soil
      pipe, unless otherwise noted.

   C. All acid resistant waste piping and all acid resistant vent piping shall be:
      1. Chlorinated polyvinyl chloride (CPVC).

   D. Floor drains shall be furnished with trap primer connections, as shown on the
      Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Installation of drains and cleanouts shall be in accordance with manufacturer's
      instructions and recommendations.

   B. Installation of piping shall be in accordance with Section 15143, Installation of
      Plumbing Piping.

   C. All waste and vent piping in chases shall pitch uniformly at a 1/4-inch per foot grade,
      otherwise waste and vent piping shall pitch uniformly at 1/8-inch per foot grade,
      unless otherwise shown on the Drawings.

   D. Trap primers and distribution units shall be furnished and installed where shown on
      the Drawings and as required by the Phoenix Plumbing Code.
E. Accessible cleanouts shall be furnished and installed as shown on the Drawings and as required by the Phoenix Plumbing Code.

F. Plastic hub and spigots shall be provided for adapting CPVC pipe to cast iron fittings.

G. Provide 18 gage galvanized steel drip pans under all pipes that pass over or near electrical control equipment. Drip pans shall be furnished with 1-1/2-inch diameter "tell-tale" drains terminating 6-inches above the floor in a corner or near a column.

3.2 FIELD QUALITY CONTROL


++ END OF SECTION ++
SECTION 15410

PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, tools and incidentals as shown on the Drawings, specified and required to furnish, install, clean, test and adjust all plumbing fixtures and trim.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
1. Building Codes: Comply with applicable requirements of all governing authorities and the following codes:
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. FS WW-P-541b, Plumbing Fixtures-Land Use.
4. ANSI A117.1 Accessible and Useable Building and Facilities.
5. ANSI/ASME Requirements for Low Consumption, Water Conservation Requirements.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's data, specifications, dimensions, sizes, materials of construction and accessories of the following:
   a. Water closets, flush valve, seat and carrier.
   b. Lavatories, faucets, trim, drain and carrier.
   c. Urinal, flush valve and carrier.
   d. Mop receptor, faucet and accessories.
   e. Service sink, trap standard and faucet.
   f. Assembly of parts list for flush valves, faucets, electric water cooler.
   g. 1/4-inch scale drawings, prepared by CONTRACTOR showing the layout, dimensions and mounting heights of all plumbing fixtures.
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 01781, Operation and Maintenance Data.

1.4 JOB CONDITIONS

A. Protection: At the end of each day's Work or other stopping point throughout the construction, provide temporary covering over all plumbing fixtures and trim, as required, to prevent damage due to moisture, dirt, plaster, concrete or other material. As each fixture is installed, it shall be protected with temporary wood crating and the chromium-plated brass trim shall be covered with vaseline. Chipped, cracked, dented or damaged fixtures or trim will not be accepted in the finished installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Water Closet Type WC-1:
   1. Product and Manufacturer: Provide one of the following:
      b. Kohler.
      c. Eljer.
      d. Or equal.
   2. Type: Tank, 1.6 GPF.
   3. Style: Floor mounted, elongated bowl.
   4. Standards: Conform to applicable local requirements.
   5. Accessories:
      a. Float valve.
      b. Seat and Cover:
         1) Product and Manufacturer: Provide one of the following:
            a) Church Corporation.
            b) Kohler.
            c) Or equal.
         2) Standards: Conform to applicable local requirements.
         3) Type: Solid plastic, elongated, open front.
         4) Color: White.
   6. Closet Supports:
      a. Freestanding.
B. Lavatory Type L-1:
1. Product and Manufacturer: Provide one of the following:
   a. Eljer.
   b. Kohler.
   c. Or equal.
   2. Type: Flat slab, front overflow for concealed arm support.
   5. Faucets:
      a. Product and Manufacturer: Provide one of the following:
         1) Moen, Division of Stanadyne.
         2) Delta Faucet Company.
         3) Or equal.
      b. Type: 4-inch centerset faucet, aerator and single lever control.
      c. Inlets: 1/2-inch male threaded with coupling nuts.
      d. Material: Chrome plated brass.
      e. Flow Restrictor:
         1) Product and Manufacturer: Provide one of the following:
            a) Dole Energy Controls.
            b) Eaton Corporation, Controls Division.
            c) Or equal.
         2) Type: 0.5 gpm flow controllers shall be installed on each hot and cold
            water supply to each lavatory.
   6. Supplies:
      a. Product and Manufacturer: Provide one of the following:
         1) Eljer.
         2) Kohler.
         3) Or equal.
      b. Description: Lavatory supply assembly, 3/8-inch angle valve, wheel
         handle, inlet 3/8-inch male threads, escutcheon, with set screw flexible tube
         riser 3/8-inch by 12-3/4-inch.
      c. Material: Chrome plated brass.
      d. Accessories: 1/2-inch-coupling nuts for supply connection to faucet inlets.
   7. Drain Plug:
      a. Product and Manufacturer: Provide one of the following:
         1) Eljer.
         2) Kohler.
         3) Or equal.
      b. Description: Cast grid strainer with 1-1/4-inch tailpiece assembly, chrome
         plated.
   8. Trap:
      a. Product and Manufacturer: Provide one of the following:
         1) Eljer.
         2) Kohler.
         3) Or equal.
b. Description: Adjustable cast brass "P" trap with cleanout. Slip joint inlet and 17 gauge tubing outlet to wall with escutcheon, 1-1/4-inch inlet by 1-1/2-inch outlet, chrome finish.

9. Carrier:
   a. Product and Manufacturer: Provide one of the following:
      1) Jay R. Smith.
      2) Zurn Industries with 2-inch escutcheon.
      3) Or equal.
   b. Description: Floor mounted concealed arm carrier for flat slab lavatories with chrome-plated escutcheons.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All fixtures shall be installed in accordance with manufacturers printed instructions and recommendations.

B. Each fixture shall have wheel handle control stops or integral screwdriver stops for hot and cold water.

C. Coordinate shower valve assembly installation with installation of shower stall, shower partitions and base.

D. Lavatory faucets for handicapped and non-handicapped utilization shall match.

E. Insulate drain, trap, hot and cold water supply lines under handicapped lavatories.

3.2 ADJUSTMENT AND CLEANING

A. Upon completion of the Work, all labels shall be removed, fixtures and trim shall be cleaned of all dirt, grease and markings and all valves properly adjusted.

++ END OF SECTION ++
SECTION 15732

HEAT PUMP UNIT

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 outdoor wall mounted heat pump units complete and operational with, motors and appurtenances required for proper operation and to comply with requirements as shown on the Drawings and specified.

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. Testing Agencies: Fans and coils shall conform to the latest edition of the following standards:
   2. Refrigerant coils shall be certified under ARI Standard 410-87.
   3. ASHRAE 52-76 Method of testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
   1. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.
   3. Institute of Electrical and Electronic Engineers, (IEEE).
   5. City of Phoenix – Amendments to the National Electrical Code.
1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Dimensions and weights.
   3. Cooling section performance data.
   4. Heating section performance data.
   5. Manufacturer's literature, illustrations, specifications, noise data and engineering data.
   6. Fan performance curves showing operating points, and sound data.
   7. Wiring diagrams.
   8. Fabrication methods, assembly, installation details and accessories.
   9. Painting system.
   10. Other materials and data related to specified equipment as requested by the ENGINEER.

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 01781, 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. Wall penetrations shall be capped to prevent weather from entering building prior to installation of unit.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Product and Manufacturer: Provide one of the following:
   1. Marvair, Model (HVPAZ4HP).
   2. Equal.

2.2 DETAILS OF CONSTRUCTION

A. General:
   1. Air flow configuration: Horizontal flow.
   2. Operating range shall be between 120°F and 0°F cooling a standard from the factory for all units.
   3. Cooling performance shall be rated in accordance with ARI testing procedures.
   4. All units shall be factory assembled, internally wired, fully charged with R-410A and 100 percent run-tested before leaving the factory.
   5. Wiring internal to the unit shall be colored and numbered for simplified identification.
   6. Units shall be UL listed and labeled.
   7. Minimum performance data for each unit shall be as scheduled on the Drawings.

B. Casing:
   1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 500 hours in a salt spray test in compliance with ASTM B117.
2. Cabinet construction shall allow for all maintenance on one side of the unit. Service panels shall have lifting handles and be removed and reinstalled by removing not more than three screws on the units while providing a water and air tight seal.
3. Top cover shall be sloped to prevent water leakage.

C. Filters:
1. General:
   a. Filter efficiency and weight arrestance shall be determined in accordance with ASHRAE Standard 52-76, air cleaning devices used in general ventilation for removing particulate matter.
   b. Product and Manufacturer: Provide one of the following:
      1) Farr Company.
      2) American Air Filter, SynderGeneral Corp.
      3) Or equal.
2. Throwaway Filters:
   a. Filters shall be of the pleated media throwaway type and shall have a 2-inch thick fiberglass media contained in a rigid frame. Filters shall have a rigid supporting maze across both the entering and leaving faces of the media. Filters shall be sized so as not to exceed scheduled face velocities and clean filter air pressure drops.
   b. Filters shall be UL Class II rated, have an average arrestance of 82 percent, have a dust holding capacity of 75 grams per square foot at 0.25-inch w.g. resistance, and have a rated average dust spot efficiency of not less than 30 percent.

D. Compressors:
1. Direct drive, hermetic, scroll type compressors with centrifugal type oil pumps.
2. Motor shall be suction gas cooled and shall have a voltage utilization range of plus or minus ten percent of unit manufacturer's nameplate voltage.
3. Internal spring isolation and sound muffling to minimize vibration transmission and noise.
4. Winding temperature limits and compressor overloads shall be provided.
5. High & Low pressure switches shall be standard.

E. Refrigerant Circuits:
1. Each refrigerant circuit shall have factory installed independent fixed orifice to thermal expansion devices, service pressure ports and refrigerant line filter driers factory installed.
2. An area shall be provided for replacement of suction line driers.

F. Evaporator and Condenser Coils:
1. Internally finned 3/8-inch copper tubes mechanically bonded to aluminum plate fins.
2. Coils shall be leak tested to 200 psig and pressure tested to 450 psig.
3. All dual compressor units shall have intermingled evaporator coils.
G. Outdoor Fans:
   1. Outdoor fans shall be direct-drive, statically and dynamically balanced, draw through in the vertical discharge position.
   2. Fan motors shall be permanently lubricated and have built-in thermal overload protection.

H. Indoor Fan:
   1. FC centrifugal fans, belt driven with adjustable motor sheaves for units above five tons and direct drive for units five tons and lower.
   2. Adjustable idler-arm assembly for quick-adjustment to fan belts and motor sheaves.
   3. All motors shall be thermally protected.

I. Controls:
   1. Unit shall be completely factory wired with necessary controls, starters and contactor pressure lugs or terminal block for power wiring.
   2. Provide remote wall mounted thermostat.
   3. 5-minute time compressor time delay for short cycle protection.

J. Defrost Controls:
   1. Time initiated, temperature terminated defrost system.
   2. Adjustable limits between of 30, 60, or 90 minutes.

K. Accessories:
   1. Outside Air Damper:
      a. Allows up to 25% outside fresh air.
   2. Top Rain Flashing

2.3 SURFACE PREPARATION AND PAINTING

   A. Condenser coils shall be factory coated with a four coat dry phenolic coating system minimum two to three mils dry film thickness total, of Heresite Series VR-500 or equal.

PART 3 - EXECUTION

3.1 INSPECTION

   A. Examine unit for proper location and dimensions.

   B. Examine piping, ductwork, insulation, and electrical connections prior to installing unit for defects, errors, or omissions which would prevent installation of the unit.
C. Examine equipment at time of delivery for damaged or missing components.

D. Do not proceed with installation of equipment until all items found defective upon examination have been corrected in accordance with the recommendations of the manufacturer and approved by ENGINEER.

3.2 INSTALLATION

A. Mount unit to wall

B. All units shall be installed with Type 316 stainless steel anchor bolts as specified in Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

C. Make final connections of ductwork, piping and control wiring as detailed on the Drawings and approved Shop Drawings.

D. Install equipment in accordance with manufacturer's installation instructions and recommendations.

3.3 ADJUSTMENT

A. Adjust belts for proper tension.

B. Adjust pulleys for proper fan speed.

C. Adjust damper linkages for proper operation.

3.4 CLEANING

A. Clean debris from interior and exterior of unit.

B. Remove debris and waste materials resulting from installation.

C. Touch up all chips in factory finishes.

D. Replace filters used during start-up and adjusting with clean filters.
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 2 visits, minimum 2 hours on-site for each visit, to the site. The first visit shall be for checking the completed installation and start-up of the system. The second visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the packaged heat pump unit conforms 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.

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<th>Equip. No.</th>
<th>Location</th>
<th>Cooling</th>
<th>Mechanical Heating</th>
<th>Condenser</th>
<th>Evap</th>
<th>Unit Power</th>
<th>Air Fan</th>
<th>Additional Requirements (see Notes at End of Schedule)</th>
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<td>Condenser</td>
<td>Total Capacity Minimum MBH</td>
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<td>Evap</td>
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<td>59/54</td>
<td>115</td>
<td>11.5</td>
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Notes:
1. Roof Mounted Single Unit Package.
2. Base/floor Mounted Single Unit Package.
5. Side/Top Supply Discharge Connection.
7. Bottom Supply Discharge Connection.
8. Bottom Return Connection.
10. 120 Volt Control Voltage.
11. 24 Volt Control Voltage.
12. Provide Indoor Air Handling Unit with Direct Drive Fan.
13. Provide Indoor Air Handling Unit with Belt Drive Fan and Adjustable Sheaves.
14. Provide duct mounted Fan Coil Unit in accordance with Section 15841 sized for scheduled conditions.
16. Provide Economizer.
17. Provide blank off plate.
18. Thermostat Provided by Contractor.
19. Thermostat Provided by AC Unit Manufacturer.
20. Control system specified in Section 15936.
21. Provide condensing unit sized per air handler manufacturer to provide cooling requirements as indicated for associated air handler.
22. Wall mounted unit with self-contained controls.
23. Supply/return grilles and ductwork provided by air conditioning manufacturer.
24. Include service option with return-air smoke detector sensor to be wired in field to shut down unit upon detection of smoke.

++ END OF SECTION ++
SECTION 15831

CENTRIFUGAL FANS

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 centrifugal fans complete and operational with accessories.

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. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
2. Underwriters' Laboratories, Incorporated (UL).
4. City of Phoenix – Amendments to the National Electrical Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
3. Underwriters' Laboratories, Incorporated (UL).
5. City of Phoenix – Amendments to the National Electrical Code.

D. Source Quality Control: Perform the following tests and inspections at factory:
1. Fan wheels shall be statically and dynamically balanced.
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.
      b. Materials of construction.
      c. Mounting details.
      d. Performance Data - AMCA approved fan curves, for each model specified.
      e. Prefabricated curb details.
   2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Test Reports: Submit the following test certifications for approval.
   1. AMCA Label.
   2. UL Label.

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 01781, 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 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.
PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Product and Manufacturer: Provide one of the following:
   1. Loren Cook Company, Model GC-146.
   4. Or equal.

B. Type: Double inlet, forward curve, centrifugal fan with fixed discharge.

C. Capacity: 75 CFM at 0.25 inch water column.

D. Construction:
   1. Housing: 22 ga. galvanized steel.
   3. Integral backdraft damper and white plastic intake grille.

E. Motors:
   1. Permanently lubricated 1-speed motor with built-in thermal overload protection and disconnect plug.
   2. 115/1/60, 0.4 amps.

F. Drive:
   1. Direct through motor shaft.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine Pads to Receive Fans for:
   1. Proper anchor bolt locations.
   2. Unevenness, irregularities and incorrect dimensions.

3.2 INSTALLATIONS

A. Installation shall be in accordance with the manufacturer's instructions and recommendations.

B. Installation shall include furnishing and applying an initial supply of grease as recommended by the manufacturer.
C. Ductwork shall be supported independently of fan.

D. Check and align fan and motor.

3.3 START-UP ADJUSTMENT AND TESTING

A. Grease bearings, if required, prior to starting fans.

B. Check for proper rotation.

C. Adjust fans for proper air flow.

D. Leave fans in working order.

3.4 CLEANING

A. Clean dirt and marks and other debris from exterior of fans.

B. Remove debris and waste material resulting from installation.
SECTION 16050

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 01301 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 Section 16215.
         4) Single Line Diagram and Power Panel Schedule Record Documents.

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. Work Installed by CONTRACTOR But Furnished By Others:
1. Reconnection and commissioning of all electrical equipment indicated on the Drawings as TO REMAIN.
2. Coordination of work by Salt River Project (SRP).

E. Temporary Power and Lighting:
1. Refer to Section 01511, Temporary Electricity, for temporary power during construction.
2. Refer to Section 01512, 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.

F. 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. Power Company: Work in connection with the electric service and utility metering shall be done in strict conformance with the requirements of Salt River Project (SRP). Coordinate with Alex.Babcock@SRPNET.com. A job ticket for this work has been opened: T2178392.
   b. 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. Coordinate with the City of Phoenix, Information Technology Department: Ron Schmidt; Ronald.schmidt@phoenix.gov. 602-534-1356.

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).
   3. The Institute of Electrical and Electronic Engineers (IEEE).
   4. Insulated Cable Engineers Association (ICEA).
   7. ASTM International (ASTM).
   8. The Instrumentation, Systems and Automation Society (ISA).
   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 01301, Pre-Construction Conference.
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 17001, Process Control System General Requirements for Process Instrumentation.
   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 01330, Submittals and Section 01332, 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 01781, Operation and Maintenance Data.

B. Record Drawings:
   1. Furnish 3 copies of Record Drawings in accordance with the requirements of Section 01782, 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 01661, Storage of Materials and Equipment.

C. Handling of Materials: Refer to and comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

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 02220, 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 shown on drawings.
2. Shall be Free-Stand Enclosures.
B. All control cabinet and panel materials shall meet the area classifications as stated in Section 1.9, unless otherwise specified or noted on the Drawings. Prove the following types of enclosures:
   1. NEMA 3R.
   2. Corrosive Locations, NEMA 4X.

C. Provide the following enclosure features:
   1. NEMA 3R Enclosure:
      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.

3. 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-inch x 12-inch x 6-inch 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.

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 125°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.

B. Corrosive Locations: The following areas shall be considered corrosive locations:
   1. Inside Wet Wells, interior of influent and effluent pipes
   2. Areas per NFPA 820 which will be hazardous classified.
C. Hazardous Locations: The following areas shall be considered hazardous areas as shown on the Drawings.
   1. Wet Wells, interior of influent and effluent pipes: Class 1, Division 1.
   2. Odor Control System-outside but within 3 feet: Class 1, Division 2.

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 16122, 600 Volt Cable.

2.3 CONDUIT TAGS

A. Refer to Section 16131, Rigid Conduit.
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 16215 – Power Study.

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.
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 480 VOLTS, Part # 43141.
   b. Or Equal.

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](danger_label.png)

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](danger_label2.png)
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.

++ END OF SECTION ++
SECTION 16061

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:

1.3 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 16000-N in Specification 01331 – 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, 10 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-inch x 22-inch minimum.
   b. Inside Locations: 10-inch x 17-inch 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-inch 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.

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 Brown and Caldwell 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 16000-N as provided in Specification 01331 – 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part No.</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Two Part Non-Sag Epoxy</td>
<td></td>
<td>Hardman</td>
</tr>
<tr>
<td>2</td>
<td>Stainless Steel Wire/ 30 ft roll</td>
<td>38091</td>
<td>Brady</td>
</tr>
<tr>
<td>3</td>
<td>Zinc Wire Clamps 50/pk</td>
<td>38090</td>
<td>Brady</td>
</tr>
<tr>
<td>4</td>
<td>Aluminum Tag - Green</td>
<td>49908</td>
<td>Brady</td>
</tr>
</tbody>
</table>

D. Tests shall be witnessed by the ENGINEER and OWNER.

++ END OF SECTION ++
SECTION 16121

CONTROL (INSTRUMENTATION) 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. Single Conductor Control Cable.
      b. Shielded Cable.
      c. Unshielded Cable.
      d. Telephone Cable.

1.2 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for instrumentation cable proposed for use.
   2. 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 16122.2.1.A.

B. 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.
C. Telephone Cable:
   1. 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-hygrosopic 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.
   2. Product and Manufacturer: Provide one of the following:
      a. Anixter.
      b. Or equal.

D. Intercom and Paging System Cable:
   1. 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.
   2. Product and Manufacturer: Provide one of the following:
      b. Mohawk.
      c. Or equal.

E. Cable Terminals:
   1. Provide ferule compression fittings or UL listed fork type copper compression terminals with nylon insulation for termination of cable at all terminal blocks.
   2. For Panels provided under 17260, see Section 17260 - Field Wire Termination for termination methods, product and manufacturer.
   3. Product and Manufacturer: Provide one of the following:
      a. T&B Sta-Kon.
      b. Burndy Insulug.

F. Cable/Wire Markers:
   1. Provide only heat shrinkage type cable/wire identification, which shall be typewritten.
   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 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:
      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 16122.
   2. Telephone 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.
   4. 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.)

B. 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.

C. 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.

D. Terminate stranded conductors with pre-insulated crimp type spade or barrel compression fitting terminals properly sized to fit fastening device and wire size.

E. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.

F. Coordinate the installation and termination of the telephone cables with the City of Phoenix, Information Technology Department.

G. Install in conformance with the National Electrical Code and the City of Phoenix Electrical Code.
H. 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

A. Test all 600 volt wiring in accordance with the requirements of Section 16122,
   600 Volt Cable.

B. 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.

C. Connect shielded instrumentation cables to a calibrated 4 to 20 mADC signal
   transmitter and receiver. Test at 4, 12 and 20 milliamp transmitter settings.

D. 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.

++ END OF SECTION ++
SECTION 16122

600 VOLT 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 600 volt cable.
   2. The types of cable required include the following:
      a. Insulated cable for installation in raceways.

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 B3, Soft or Annealed Copper Wire.
   2. ASTM B8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
   5. City of Phoenix – Amendments to the National Electrical Code.
   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 B3 and B8 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 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.

C. 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.

D. 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 3 - EXECUTION

3.1 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) - White.
   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.

3.2 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.

F. Where existing cables are spliced to cables provided under this Contract, the existing cables shall be tested prior to splicing. Test cables at 1,000 volts DC for one minute. The entire spliced cable installation shall be re-tested after the splice is completed. Any existing cable which fails or has a value less than two megohms shall be brought to the ENGINEER'S attention and the splicing shall not proceed. Tests shall be witnessed by the ENGINEER.

++ END OF SECTION ++
SECTION 16131

PVC COATED RIGID METAL CONDUIT, RIGID NONMETALLIC CONDUIT, ELECTRICAL METALLIC TUBING

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 45 degrees 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)
         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) Not permitted for this job.

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.

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 (ITPs), 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-inch x 17-inch).
   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 01782-1.1, 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.

   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 1/2 inch through 2 inches. Conduit or fittings having areas with thin or no coating shall be unacceptable. Do not use "LB" fittings for conduit sizes of 1-1/4 inches or larger. Use type "LBD" fittings wherever the use of fittings for conduit sizes of 1-1/4 inches 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.

   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.

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.

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, 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 Hollow Masonry Units: Type 316 Stainless Steel toggle bolts.
   2. To Brick Masonry: Type 316 Stainless Steel Price expansion bolts, or equal.
   3. To Concrete: Refer to Section 05051.
   4. 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" Section 03300.
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.
5. Minimum 2-inch trade diameter.
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 degrees. Length of run between manholes shall be limited to:
1. 300 feet with 270 degrees in bends.
2. 600 feet with 180 degrees in bends.
3. 1000 feet with 90 degrees 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.
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.
   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/Gedney.
   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 LINK-SEAL.

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/Gedney.

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 prior to core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit in accordance with Section 01723, 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 shown on CONTRACT DRAWINGS.

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 ++
SECTION 16132

FLEXIBLE CONDUITS

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 351, 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 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:
      b. Appleton Electric Company.
      c. Or equal.

C. 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 ++
SECTION 16133

SEALING 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 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:
   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 ++
SECTION 16135

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:
   b. O-Z/Gedney 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.

7. All boxes shall be identified in accordance with Section 16050, General Provisions.

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, 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 16136
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 outlet boxes for mounting wiring devices and lighting fixtures.

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. 514, Electrical Outlet Boxes and Fittings.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturers technical information for outlet boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Device Boxes:
   1. Material: Cast gray iron alloy, or cast malleable iron, with zinc electroplate finish in wet locations and zinc-coated sheet steel in dusty locations. Cast boxes shall be hub type and include external mounting lugs. In corrosive locations, boxes shall include a factory applied 40-mil PVC coating. In dusty locations, where conduit is installed concealed, boxes shall be steel galvanized and shall include suitable extension rings and covers, as required.
   2. Device Cover Plates:
      a. Stainless steel Type 302 alloy for indoor finished areas.
      b. Gasketed spring door type for wet and corrosive locations. Plates in corrosive locations shall include a factory applied 40-mil PVC coating.
      c. Integral with device for hazardous locations.
      d. Stainless steel screws and hardware.
3. Manufacturer: Provide device boxes of one of the following:
   b. Appleton Electric Company.
   c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten boxes rigidly and neatly to supporting structures.

B. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.

C. Leave no open conduit holes in boxes. Close unused openings with capped bushings.

D. Label each circuit in boxes and identify in accordance with Section 16122, 600 Volt Cable.

E. Install in conformance with Phoenix Electrical Code.

++ END OF SECTION ++
SECTION 16137

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.

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 01782, Record Documents.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Duct: Schedule 40 PVC conduit and fittings in accordance with Section 16131 - PVC Coated Rigid Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing.

B. Exposed: PVC Coated Galvanized Rigid Metal Conduit: PVC coated rigid metal conduit and fittings in accordance with Section 16131, Rigid Conduit, if required.

C. Backfill: Select backfill in accordance with Section 02315, Structural Excavation and Backfill.

D. Reinforcement: In accordance with Section 03200, Concrete Reinforcement.

E. Concrete: In accordance with Section 03300, Cast-In-Place Concrete.

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 16131 - PVC Coated Rigid Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing.

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 90-degree 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 16131.

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 16131 - PVC Coated Rigid Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing.

++ END OF SECTION ++
SECTION 16138  
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.

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 A48, Class 30A.
      b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised 2-inch
         letters. Identify covers as shown on the Drawings.
      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.
   2. Frames and Covers:
      a. Material: Covers and frames shall be cast aluminum alloy, sidewalk load
         rated.
      b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised 2-inch
         letters. Identify covers as shown on the Drawings.
         1) Handhole covers to be sized for a 24-inch box.
      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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install 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 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. 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.
D. 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 16141

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:
   2. UL Standard No. 1010, Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.

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.
         3) Or equal.
B. 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

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 16136, Outlet Boxes, in non-hazardous locations.

B. Install receptacles with ground pole in the down position.

C. Mount receptacles in accordance with drawings.

D. Identify each conductor with the circuit number and the lighting panel number.
   Identification shall conform to the requirements of Section 16122, 600 Volt Cable.

E. Identify each receptacle with a permanent self adhesive label. Approximate size
   3/8 inch x 1-1/4 inches. The label shall include the panel name and circuit number.
   1. Product and Manufacturer: Provide one of the following:
      a. Catalog No. PTL-45422 by Brady.
      b. Or Equal.

F. Install in conformance with Phoenix Electrical Code.

++ END OF SECTION ++
SECTION 16143
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidental 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 16142.
   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.
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.

C. Enclosures:
   1. In all other locations except wet or corrosive, NEMA 4X 304 stainless steel.
      For wet or corrosive locations, NEMA 4X 316 stainless steel.

D. Identification:
   1. Identify all enclosures in accordance with Section 16050, 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 01630, Computerized Maintenance
      Management System Tags.

E. Product and Manufacturer: Provide one of the following:
   1. Square D Company.
   2. General Electric Company.
   3. Allen Bradley.

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 16215

POWER SYSTEM / ARC FLASH ANALYSIS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General:
   1. A Power System Short Circuit Study, Protective Device Coordination Study, and Arc Flash Analysis for the Electrical Distribution System (EDS) shall be performed for the work as specified in the CONTRACT DOCUMENTS.
   2. The CONTRACTOR shall coordinate with the OWNER's Electrical, Instrumentation and Control (EI&C) Inspection Firm as outlined in this specification to perform the POWER SYSTEM / ARC FLASH ANALYSIS. The EI&C Inspection Firm shall here in be referred to as ANALYSIS FIRM.

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 16000 Engineer approved submittals, including the ENGINEER'S 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, Addenda, 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 ANALYSIS FIRM 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. ANALYSIS FIRM shall supply and CONTRACTOR shall install labeling as required by specification 16050 section 3.1 for voltage labeling and other labels as required.

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
   2. IEEE 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   4. NFPA 70E, Standard for Electrical Safety in the Workplace
   5. ANSI C37.010, Method of Short Circuit Analysis
   6. NFPA 70, National Electrical Code (NEC)

1.4 SUBMITTALS

A. Preliminary Power System / Arc Flash Analysis Report:
   1. The ANALYSIS FIRM will provide a preliminary submittal review and prepare a Preliminary Report providing comments for equipment submitted on. This will be submitted for approval by the ENGINEER and OWNER. After approval by the ENGINEER and OWNER, the information in the finalized Preliminary Report shall be provided to the CONTRACTOR to ensure the EDS electrical equipment order being released for manufacturing meets the requirements of the Project.
PART 2 - PRODUCTS

2.1 LABELS

A. Arc Flash Potential Labels:
   1. Category Label:
      a. A standard Arc Flash Warning label shall be installed on all equipment
         with a Category 1 or 2 with available fault current less than 25kAIC. All
         other components must have an equipment specific label generated from
         SKM using calculated values as described in 2.2.A.2.
      b. Label format shall be: 2.5” x 3.5” with coloring to match one of the labels
         shown on Figure 2.2.B.1 below.

---

**WARNING**

**Arc Flash and Shock Hazard**

| PPE Category Required Per NFPA 70 E Table |
| Category 1 Minimum Arc Rating of 4 cal/sq. cm @ Working Distance of 18 Inches |
| 120-208/240 VAC w/ Isc <25kA |
| Arc Flash Boundary = 19 Inches |

---

**WARNING**

**Arc Flash and Shock Hazard**

| PPE Category Required Per NFPA 70 E Table |
| Category 2 Minimum Arc Rating of 8 cal/sq. cm @ Working Distance of 18 Inches |
| 277/480 VAC w/ Isc <25kA |
| Arc Flash Boundary = 36 Inches |

Figure 2.2.B.1
2. Calculated Specific Equipment Labels:
   a. Arc Flash Potential Warning labels shall be installed on all equipment with a calculated energy level.
   b. Labels shall be standard 4” x 5” rectangular labels.
   c. Label format with coloring to match Figure 2.2.B.2 below.

**WARNING**

<table>
<thead>
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<th>Arc Flash and Shock Hazard</th>
<th>Appropriate PPE Required</th>
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</thead>
<tbody>
<tr>
<td>480 VAC</td>
<td>Shock Hazard when cover is removed</td>
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<tr>
<td>94 in</td>
<td>Flash Hazard Boundary</td>
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<tr>
<td>18 cal/cm²</td>
<td>Flash Hazard at 18 Inches</td>
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<tr>
<td><strong>Level 3</strong></td>
<td><strong>Minimum Rating of 25 cal/sq cm</strong></td>
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<tr>
<td>42 Inches</td>
<td>Cotton Underwear + AR Shirt &amp; Pants or AR Arc Flash Suit + AR Flash Hood</td>
</tr>
<tr>
<td>12 Inches</td>
<td>Limited Approach</td>
</tr>
<tr>
<td></td>
<td>Restricted Approach</td>
</tr>
</tbody>
</table>

**EQUIPMENT:** 
**SES LOAD SIDE MAIN**

- **SKM SLD:** 001 1 Line-UH-All
- **Firm:** ABC Electrical
- **Contact Info:** (123) 456-7890
- **Date:** 01/01/2000

**Warning:** Changes in equipment setting or system configuration will invalidate the calculated values and PPE requirements

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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. Product Manufacture shall be the following:
      1) **Printer and Label Materials**
         a) BRADY Powermark Printer, BRADY Label Part# 13651
         b) Or Equal.
PART 3 - EXECUTION

3.1 BREAKER SETTINGS

A. The CONTRACTOR shall coordinate with the ENGINEER and ANALYSIS FIRM to implement the breaker settings defined in the Preliminary Power System / Arc Flash Analysis Report.

   1. ANALYSIS FIRM will provide a breaker setting table with sign off form for CONTRACTOR's use during implementation of breaker settings.
   2. The CONTRACTOR shall complete form 16215 - 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 Power System / Arc Flash Analysis Report with the actual settings. CONTRACTOR or ENGINEER shall provide written justification for any deviations from the Preliminary Report.

3.2 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 Final Power System / Arc Flash Analysis Report with the final settings.

3.3 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 label and voltage label. ANALYSIS FIRM shall determine the proper arc flash label. CONTRACTOR shall affix labels as requested by ANALYSIS FIRM.

   1. Install all labels level and in an upright position. Do not cut or alter in any way. Install label 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. Where equipment does not have sufficient space for an Arc Flash Label the CONTRACTOR shall furnish a fabricated mounting plate constructed of Type 316 stainless steel sheet metal per direction from the ENGINEER and ANALYSIS FIRM. Mounting plate shall be affixed to the equipment using Type 316 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.
4. 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.

5. For outdoor switchgear, place a single Arc Flash 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 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.

6. For disconnect switches, panel boards, distribution boards, load centers, and control cabinets, the labels should be applied in plain view on the front cover.

++ END OF SECTION ++
SECTION 16231

480 VOLT STANDBY POWER GENERATOR SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide all labor, materials, equipment, and incidentals as required to furnish and install, natural gas engine-generator set complete with all appurtenances as shown on the Drawings, specified and required for complete operational natural gas engine generator standby power systems where required by the Drawings. The generator is to be a 1-for-1 replacement of the existing generator with the same capacity machine.

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 3,000 hours of operation. Warranty shall provide for free replacement or repair of parts for the five years or 3,000 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.
   4. Underwriters' Laboratories Incorporated (UL).
   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.
8. IEEE Std. 126-1959/83, Speed Governing of Internal Combustion Engine-Generator Units.
17. NEMA MG1, Motors and Generators.
18. UL Standard No. 1008 Standard For Safety.
19. UL Standard No. 142 Steel Above Ground Tanks.
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.


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.


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.

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 01781, 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. 200 kW, 250 kVA, 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 natural gas, 1,800 rpm, maximum bore-to-stroke ratio of unity. 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, 120 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 natural gas. System to include dry element air cleaners, an electronic governor and the following:
1. Governor: Electronic, speed droop externally adjustable, isochronous to five percent.

F. 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.

G. 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 Model, 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.

H. 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 (RTDs) to monitor a minimum of six temperature zones, covering all three phases, in the
generator windings. The RTDs 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.

I. 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 natural gas 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. 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.
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. Battery voltage low (Warning Alarm).
   i. Battery voltage high (Warning Alarm).
   j. Generator running.
   k. Overspeed (Shut Down).
   l. Anticipatory low oil pressure (Warning Alarm).
   m. Anticipatory high water temperature (Warning Alarm).
   n. Manual emergency stop (Shut Down).
   o. Not in automatic (Warning Alarm).
   p. System ready.
   q. Battery charger fault (Warning Alarm).
   r. High high generator temperature (Shut Down).
   s. Battery weak at time of cranking (Warning Alarm).
   t. Overcurrent (Warning Alarm).
   u. Overcurrent (Shut Down).
   v. High AC voltage (Shut Down).
   w. Low AC voltage (Shut Down).
x. Under frequency (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.
17. Main circuit breaker, rated as shown on the Drawings.
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.

J. 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.

K. Generator Base:
1. Base shall be a structural steel frame of adequate rigidity for generator and engine alignment.
L. 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 05051, 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.

M. 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.

N. Manufacturer Nameplate: In accordance with the requirements of NEMA MG1-22.61.

O. 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.

P. 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 01783, Spare Parts and Maintenance Materials.

Q. Product and Manufacturer:

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 09900, 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 09900, Painting.

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 09900, Painting.

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 visits, minimum four 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 01821, 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 incidental expenses, shall be considered as included in CONTRACTOR’S bid price.

++ END OF SECTION ++
SECTION 16282

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.
3. NFPA (70 [NEC], 75 and 78).
   a. Each system component shall be UL Standard No. 1283, Listed as an Electromagnetic Interference Filter.

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.
   a. Provide complete copy of Warranty; refer to requirement of paragraph 2.2.G of this Specification.
2. Provide verification that the SPD complies with the required UL Standard No. 1449 VPRs.
3. Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 6kV/3kA combination wave tested in accordance with ANSI/IEEE C62.45.
4. 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 01781, 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: 1,200 volts.
   2. Line to Ground: 1,200 volts.
   3. Neutral to Ground: 1,200 volts.
   4. Line to Line: 2,000 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 Varistors (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. Square "D" Company.

2.3 ACCESSORIES

   A. The unit must be equipped with surge event counter.

   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 ++
SECTION 16423

MOTOR CONTROL CENTERS

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 motor control centers and modify existing motor control centers.

B. Coordination: Obtain motor nameplate data on equipment being furnished for properly sizing circuit breakers, starters and overloads.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. UL Standard #845, Electric Motor Control Centers.
   2. NEMA ICS2-322, AC General Purpose Motor Control Centers.
   4. 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 motor control centers proposed for use.
   2. Outline and summary sheets with schedules of equipment in each unit.
   3. Unit control schematic and elementary wiring diagrams showing numbered terminal points, interconnections to other units, wire colors and wire labels.

B. 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 01781, Operation and Maintenance Data.
PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Motor control center lineups shall be provided as shown on the Drawings. Motor control centers including structures, appurtenances and all major components (contactors, circuit breakers, etc.) therein shall be the product of one manufacturer.

1. Service: Voltage rating and number of wires shall be as shown on the Drawings. Motor control centers shall operate from a 3 phase, 60 Hertz system. 480 volts, 3 phase, 3 wire. UL rated as suitable for service entrance.

2. Wiring: NEMA Class II, Type B. Color coding shall conform to NFPA 79.

3. Enclosure: NEMA 3R.

4. Main shall have a symmetrical interrupting rating of 65,000 amps.

5. Circuit breakers with trip ratings over 800 amps shall have integral ground fault protection.

B. Construction:

1. Totally enclosed structure, dead front, consisting of nominal 21-inch deep, 24-inch wide, 90-inch high vertical sections bolted together to form a unit assembly.

2. Removable lifting angles for each shipping section.

3. Two removable floor sills for mounting.

4. Horizontal wireways top and bottom, isolated from horizontal bus and readily accessible.

5. Isolated vertical wireways with cable supports, accessible through hinged doors, for each controller section.

6. All metal non-conducting parts electrically continuous.

7. NEMA 3R enclosures with gaskets and fan filters shall fully enclose NEMA 1 MCC sections.

C. Bus System and Conductors:

1. Rating: Bus bracing of 65,000 amps symmetrical and bus current capacities as shown on the Drawings.

2. All bus bars shall be tin-plated copper rated to UL heat rise standards.

3. Bus bar connections shall be easily accessible with simple tools.

4. Main Horizontal Bus: Continuous edge mounted, and isolated from wireways and working areas.

5. Vertical Bus: Continuous and isolated by a glass polyester barrier.

6. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity, as required.

7. All control conductors shall be Type SIS, No. 14 AWG minimum.
D. Unit Compartments:
1. Individual front door for each unit compartment with engraved manufacturer's nameplates identifying equipment. Manufacturer's nameplates to be 1-inch by 3-inches minimum, secured to unit door with two stainless steel screws.
2. Starter and feeder-unit doors interlocked mechanically with the unit disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while door is open, with provisions for releasing the interlock for intentional access and application of power.
3. Padlocking arrangement permitting locking the disconnect device in the OFF position, with at least three padlocks, with the door closed or open.
4. NEMA 1 minimum motor starter size. Starter units completely draw-out type in Sizes 1 and 2 and draw-out type after disconnecting power leads only in Sizes 3 and 4.
5. Motor starters shall include a magnetic contactor, NEMA rated with encapsulated magnet coils. Wound coils not acceptable.
6. Reduced Voltage Solid State Starter:
   a. Manufactured and tested in accordance with the applicable requirements of IEEE, UL, and NEMA, including the following:
      1) Dielectric withstand per UL 508.
      2) Noise and RF immunity per NEMA ICS-2-230.
   b. Furnish with a motor circuit protector or thermal magnetic circuit breaker as indicated on the Drawings.
   c. Provide protection against internal faults and high SCR temperature during operation of the motor including starting, running (except when bypassed), and stopping modes.
   d. Capable of continuously delivering full rated current of the motor plus the motor service factor in ambient temperatures from 0 degrees Celsius to 40 degrees Celsius at the installed altitude.
   e. Provide a magnetically operated bypass contactor in parallel with the solid state starter:
      1) The bypass contactor to energize when the motor has reached full speed:
         a) The electronic overload protection circuits must be fully functional with the bypass contactor closed.
   f. RVSS control module requirements:
      1) Microcomputer based, and contains the required circuitry to drive the power semiconductors in the power section of the starter.
      2) Integrally mounted on the power section and requires no additional panel space or wiring.
      3) Mounted for easy wiring, testing, service, and replacement.
      4) Provide 3-phase current sensing.
      5) Quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs, and SCR gate firing output circuits.
      6) Operates on power supplied from a control power transformer.
      7) Phase insensitive or with phase rotation protection.
8) Control modes:
   a) Soft start with adjustable linear ramp time and a "kick start" or "boost" feature to provide a short time (typically 0.1 second) application of approximately full voltage.
   b) Soft start with adjustable linear ramp time, with a current limit:
      i. The current limit shall be adjustable over the range of 2 to 4 times normal full load current.
   c) Across the line starting.
   d) Reverse voltage ramp (line voltage to zero voltage):
      i. Adjustable from 2 to 30 seconds to provide smooth stop.
      ii. Automatic shutdown at end of voltage ramp.

9) Protective functions:
   a) Single phase protection.
   b) Under voltage protection.
   c) Short circuit electronic trip overcurrent protection. Time not to exceed 3 cycles.
   d) Inverse time running overcurrent protection.
   e) Auxiliary trip circuitry.
   f) Gate firing circuit lockout protection on trip.
   g) Jam and stall detection.
   h) Fault relay lockout protection.
   i) 100 percent to 130 percent full load running current trip adjustment.
   j) 100 percent to 450 percent of starting current limit adjustment.
   k) Dwell time at current limit with ramp continuation after acceleration.
   l) Individual light emitting diodes (LEDs) for trip and phase loss.
   m) Minimum and maximum initial starting voltage adjustments.
   n) Initial torque adjustment.

   g. RVSS power section requirements:
   1) 3 sets of back-to-back phase controlled power semiconductors:
      a) Minimum repetitive peak inverse voltage of 1,500 volts at 480 VAC.
      b) Resistor/capacitor snubber networks to prevent false firing of the SCRs.
      c) Equipped with individual heat sink assemblies.
      d) Provide high-speed fuses for protection of the SCR stacks against short circuit conditions.
   2) Provide metal oxide varistors for surge protection on the line side power terminal connections:
      a) Rated for a minimum of 120 joules.
   3) Capable of supplying the following current levels:
      a) 600 percent of full load current for a minimum of 10 seconds.
      b) 450 percent of full load for a minimum of 30 seconds.
4) Furnish ground lugs, one for incoming and one for outgoing ground connections.

5) Furnish pressure type terminals for top or bottom entry power terminations.

h. Remote indicators:
   1) Provide Form C dry contacts for remote indication of:
      a) Internal fault error.
      b) Undervoltage.
      c) Overvoltage.
      d) Phase reversal.
      e) Phase loss.
      f) Overload.
      g) Frequency out of range.
      h) Excessive starts per hour.
      i) Drive electronics over temperature.
      j) Stall.
      k) Jam.
      l) System failure.
      m) Starter failure.
      n) Run status.
      o) Full speed.

i. Metering:
   1) 3-phase motor current.
   2) Power in kW.
   3) Power factor.
   4) Three-phase voltage.
   5) Power usage in kWh.

j. Phase re-balance:
   1) Continuously monitor the incoming 3-phase line voltage balance and adjust the output voltage to automatically balance the 3-phase currents supplied to the motor.

7. Overload Relays:
   a. Internal function to RVSS
   b. Solid state electronic for FVNR starters.

8. Individual control power transformers for all starters, capacity as required for all control circuit devices, 100 VA minimum, Class A insulation, two primary fuses, 120 volt secondary, one secondary fuse and the other secondary leg grounded.

9. Separate Control: Where control power to starter is provided by a separate power source, a control power fuse shall be provided in the unit and the main disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open. Power source should be identified by yellow conductors, if the source is separated or foreign to the starter cubicle.
10. Motor horsepower shown are preliminary. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.

11. Auxiliary contacts, relays, timers as required for specified control functions and those shown on the Drawings.

12. All starter devices, including spare contacts wired to numbered terminal blocks.

13. Control devices shall be 600 volt heavy duty, NEMA A600. Relays shall have convertible contacts. Pilot devices shall be oil tight. Pilot lights shall be 120 VAC, push-to-test.

14. Feeder Circuit Breakers: Thermal magnetic type, 65,000 amps symmetrical interrupting capacity.

15. Motor Starter Circuit Breakers: Magnetic trip only motor circuit protectors, 65,000 amps symmetrical interrupting capacity.

16. Provide the following diagrams and tables on the inside of the door for each compartment:
   a. Elementary wiring diagram.
   b. Table of overload heater sizes with the correct heater highlighted.
   c. Table of the motor circuit protector settings with the correct setting highlighted.

17. Sections shown on the Drawings as "SPACE" shall be complete with all necessary hardware for the future installation of a plug-in unit.

E. Metering:
   1. Provide a metering device for each incoming main circuit breaker with current and potential transformers as shown on the Drawings.
   2. Metering device shall monitor and display the following information:
      a. Phase amperes (each phase): 0.3 percent accuracy.
      b. Voltage phase-to-phase: 0.3 percent accuracy.
      c. Watts: 0.6 percent accuracy.
      d. Vars: 0.6 percent accuracy.
      e. Power factor: 1.0 percent accuracy.
      f. Frequency: 0.1 hertz.
      g. Kilowatt-hours: 0.6 percent accuracy.
      h. Kilovarhours: 0.6 percent.
      i. Percent current total harmonic distortion in each phase.
      j. Percent voltage total harmonic distortion between each phase.
   3. The unit shall have the following additional features:
      a. Trend analysis which shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
      b. The input range of the device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120.
      c. Alarm contacts rated five amps at 120 VAC.
      d. Three analog outputs programmable to reflect any of the metered parameters (except kilowatt hours and kilovarhours).
e. Communications capability via a two wire RS485 Modbus RTU connection.

4. Control power shall be drawn from the monitored incoming AC line. The device shall have non-volatile memory and not require battery backup. In the event of a power failure, the device shall retain preset parameters.

5. Product and Manufacturer: Provide the following:
   a. Multilin.

F. Spare Parts:
   1. Provide the following spare parts for each motor control center lineup:
      a. Two fuses of each size and type used.
      b. One auxiliary control relay with at least two normally open and two normally closed contacts.
      c. One control transformer of each size used.
      d. Twelve indicating lamps.
   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. Deliver spare parts at the same time as the motor control centers. Comply with the requirements of Section 01783, Spare Parts and Maintenance Materials.

G. 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 3/32-inch minimum, two-ply with chamfered edges, black characters on a white background or match existing, secured with stainless steel screws. These nameplates shall also contain item designation, equipment 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.

H. Product and Manufacturer: Provide motor control centers of one of the following:
   1. Square D Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install on raised concrete base at locations shown on the Drawings. Install support channels in concrete in accordance with the manufacturer's recommendations and instructions.
B. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between motor control center and wall for corrosion protection. Trim board neatly within outline of unit.

C. Provide no openings in top or side of units not required for conduit.

D. Cable circuits together within enclosures and identify with durable tag secured to cabling twine.

E. Set motor circuit protectors at lowest setting possible which permits motor starting without nuisance tripping.

F. Field test all motor control center components.

G. Verify that wiring diagrams on inside of door of each compartment reflects the "as-built" circuitry and that the correct overload heater size and motor circuit protector setting are noted.

H. Install in conformance with Phoenix Electrical Code.

I. Furnish new manufacturer's nameplates on all new motor control centers.

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 visits, minimum four 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 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the motor control centers 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 ++
PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals, including concrete pad, as shown on the Drawings, and furnish and install Service Entrance Section.

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 Section 09900, Painting.

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.
   2. ANSI C37.20, Switchgear Assemblies.
   3. NEMA SG-3.
   4. NEMA SG-5, Power Switchgear Assemblies.
   5. NEMA SG-6, Power Switching Equipment.
   6. UL Standard No. 1558, Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

C. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. 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.
   2. Refer to and comply with the requirements of Section 01332, Shop Drawing Procedures.

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.

C. 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 01781, 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 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 01651, Transportation and Handling of Materials and Equipment and Section 01661, Storage of Materials and Equipment.

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 65,000 amps.

2.2 MATERIALS

A. General: The metal-enclosed switchgear assembly shall consist of multiple self-supporting bays. The sections shall contain PowerPact P frame molded case circuit breaker and accessories.

B. Construction:
1. SES design and installation must satisfy the requirements of Salt River Project (SRP) for the metering and disconnect functions, found in: http://www.srpnet.com/electric/business/specs/ess.aspx
2. 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.
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. All circuit breakers shall be molded case, manually operated and have a minimum of 65,000 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.
   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 Schneider Square D, Micrologic 5.0P, or equal.
   b. Each breaker shall have an energy reduction maintenance setting switch.

7. 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.

8. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device.

9. 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 "FUTURE SPACE" on the Drawings, shall be furnished with all necessary provisions for a future, manually operated circuit breaker.

C. Metering:
   1. Provide a metering device for each incoming main circuit breaker with current and potential transformers as shown on the Drawings.
2. Metering device shall monitor and display the following information:
   a. Phase amperes (each phase): 0.3 percent accuracy.
   b. Voltage phase-to-phase: 0.3 percent accuracy.
   c. Watts: 0.6 percent accuracy.
   d. Vars: 0.6 percent accuracy.
   e. Power factor: 1.0 percent accuracy.
   f. Frequency: 0.1 hertz.
   g. Kilowatt-hours: 0.6 percent accuracy.
   h. Kilovarhours: 0.6 percent.
   i. Percent current total harmonic distortion in each phase.
   j. Percent voltage total harmonic distortion between each phase.

3. The unit shall have the following additional features:
   a. Trend analysis which shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
   b. The input range of the device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120.
   c. Alarm contacts rated five amps at 120 VAC.
   d. Three analog outputs programmable to reflect any of the metered parameters (except kilowatt hours and kilovarhours).
   e. Communications capability via a two wire RS485 Modbus RTU connection.

4. Control power shall be drawn from the monitored incoming AC line. The device shall have non-volatile memory and not require battery backup. In the event of a power failure, the device shall retain preset parameters.

5. Product and Manufacturer: Provide the following:
   a. Multilin.

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 3/23-inch minimum, two-ply with chamfered edges, 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. Any additional devices as required and as shown on the Drawings.
F. Product and Manufacturer: Provide one of the following:
   1. Square "D" Company, Model QED.
   2. No exception.

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 16215, 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.

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 recommendations.

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.

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 visits, minimum four 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 01821, 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 device shall be performed by CONTRACTOR in the field in accordance with the recommended settings designated in the coordination study in Section 16215, Power System Study.

++ END OF SECTION ++
SECTION 16442

LIGHTING, INSTRUMENTATION AND DISTRIBUTION 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.
2. Installation of new circuit breakers in existing panelboards shall be included in this Section and shall be rated as specified herein.

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. 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-inch x 5-inch, placed in a 9-inch x 5-1/2-inch 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. Allen Bradley.
   d. Or equal.

B. Mini-Power Centers:

1. General: Mini-power center shall consist of an encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.

2. Transformer Rating: kVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown on the Drawings.

3. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.

4. Enclosure: Weatherproof, NEMA 3R.

5. Product and Manufacturer: Provide one of the following:
   a. Mini-Power Zone by Square D Company.
   b. Panel Tran by Acme Electric Corporation.
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 ++
SECTION 16501

LIGHTING FIXTURES AND 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 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.
   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.

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. Light Emitting Diode (LED).

C. 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.

D. 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.

E. Photocell:
   1. Integral to the fixture.

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. Surface Mounted Fixtures: Attach to appropriate outlet box.

C. 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.
D. Mounting Heights: Mounting heights or elevations are to bottom of the fixture or to centerline of device.

E. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

F. 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.
   1. Provide integral motion detection where shown.

G. Securely fasten equipment to walls or other surfaces on which they are mounted.

H. Install fixtures in conformance with Phoenix Electrical Code.

++ END OF SECTION ++
SECTION 17001

PROCESS CONTROL SYSTEM
GENERAL REQUIREMENTS

PART 1 - GENERAL

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 17, Process Controls 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 17, Process Control System or other Divisions of the CONTRACT DOCUMENTS. EQUIPMENT SUPPLIERS shall coordinate with the PCS COORDINATOR (responsibilities as defined below).

D. CONTRACTOR shall configure all Computerized Control System (CCS) software for the supplied CCS. CONTRACTOR shall be responsible for all hardware configurations, loop testing of signals, and communications testing for new and modified existing control equipment through the CCS.

E. All control loops shall function as described in Section 17051, Process Control Descriptions or other Divisions and Drawings of the CONTRACT DOCUMENTS.

F. All instruments shall be field calibrated and witnessed by the ENGINEER as stated in Specification 17052 – Process Control System Primary Sensors and Field Instruments.

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 sewage 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 01301 – Pre-Construction Conference 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 01321 – Progress Schedule (CPM) to incorporate PCS construction activities into the Progress Schedule.
      c. Attend the project Construction Progress Meetings required in Section 01312 – 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&IDs, 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 01332-A included in Section 01331 – Reference Forms for inclusion with each submittal.

3. Installation:
   a. Verify delivery and proper storage of all PCS equipment per the requirements of Sections 01651 - Transportation and Handling of Materials and Equipment and 01661 – Storage of Materials and Equipment. Complete 01661-A - Equipment Delivery Inspection Report included in Section 01331 – 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 (MOPOs) affecting PCS equipment installation or activities as required in Section 01143 – 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 17226 – 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 01331, 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 01331 –
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 17 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 01781-B – Operations & Maintenance Data Review Checklist included in Section 01331 – 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 17 Specifications and other Divisions of the CONTRACT DOCUMENTS as per Section 01821 – 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.
      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.
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. 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 01330 - Submittals and as required in other Division 17 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 01630 – 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 17000, Sections 17051 – Process Control Descriptions, 17226 – Process Control System I/O List, 17260 – Control Panels, 17262 – Programmable Logic Controller, Software and Programming and Division 16000, Section 16050 – General Conditions.

B. System Operation and Maintenance Manuals:

1. Furnish Operations and Maintenance Manuals for the PCS in accordance with Section 01781, Operation and Maintenance Data.

C. Report Forms:

1. Two (2) 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 01331 – Reference Forms shall be submitted to the PCS COORDINATOR.

1.5 EQUIPMENT DELIVERY, HANDLING AND STORAGE

A. Comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment and Section 01661, Storage of Materials and Equipment.

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 wastewater 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 16000, Section 16050 – General Requirements, unless otherwise specified.

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 17, Process Control System 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 01752 – Equipment and System Start-up 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 01331, 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 01620-A - Manufacturer's Installation Certification Form in Section 01331 – Reference 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 01821, 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 4 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 8 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 17051

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 on the CONTRACT DRAWINGS and the requirements specified herein. The CONTRACT DRAWINGS do not show all the required internal diagnostic indications. In addition to the signals shown on the CONTRACT DRAWINGS, 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).

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 power failure at any of the PLC panel shall be programmed as an alarm in the Computer Control System and identified individually to assist in troubleshooting.

4. 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.

5. Runtimes shall be programmed in the Computer Control System for all pieces of equipment unless elapse Time meters are shown on the P&IDs or listed in the loop descriptions.

6. Digital and analog signals provided from Vendor supplied equipment that are not shown on the CONTRACT DRAWINGS 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 on the CONTRACT DRAWINGS 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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRESSURE TRANSMITTERS

A. General:
1. A Pressure transmitter is provided on the common header for the lift pumps for remote and local pressure indication.

B. Monitoring and Control:
1. Field Instrumentation and Controls:
   a. PIT-105.
2. Computer Control System - Controls:
   a. Instantaneous pressure will be monitored.
3. Equipment Set Points / Ranges:

<table>
<thead>
<tr>
<th>Device</th>
<th>Set Point / Range - Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet well discharge pressure transmitter 1</td>
<td>TBD</td>
</tr>
</tbody>
</table>

C. Interlocks:
1. None.

3.2 FLOWMETERS

A. General:
1. A Flowmeters is provided on the common header for the lift pumps for remote and local flow indication.

B. Monitoring and Control:
1. Field Instrumentation and Controls:
   a. FIT-110.
2. Computer Control System - Controls:
   a. Instantaneous flow and totalized flow will be monitored. A discrete output will be provided to remotely reset the flow totalizers. A momentary pushbutton will be provided to locally reset the flow totalizer.
3. Equipment Set Points / Ranges:

<table>
<thead>
<tr>
<th>Device</th>
<th>Set Point / Range - Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-inch force main flowmeter</td>
<td>TBD</td>
</tr>
</tbody>
</table>

D. Interlocks:
   1. None.

3.3 Level Transmitters

A. General:
   1. Ultrasonic Level transmitters on the wet well and used for local and remote wet well level monitoring.

B. Monitoring and Control:
   1. Field Instrumentation and Controls:
      a. LIT-100.
      b. LIT-101.
   2. Computer Control System - Controls:
      a. Instantaneous level will be monitored.

3. Equipment Set Points / Ranges:

<table>
<thead>
<tr>
<th>Device</th>
<th>Set Point / Range - Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Well Level No. 1</td>
<td>TBD</td>
</tr>
<tr>
<td>Wet Well Level No. 2</td>
<td>TBD</td>
</tr>
</tbody>
</table>

C. Interlocks:
   1. None.

3.4 BIOFILTER

A. General:
   1. An on/off selector switch for the vendor packaged biofilter control system will control the supply fan for the biofilter. The fan shall run continuously.

B. Monitoring and Control:
   1. Field Instrumentation and Controls:
      a. PDIT-150, differential pressure transmitter.
   2. Motor - Controls:
      a. Pilot Devices on MCC bucket.
   3. Computer Control System - Controls:
      a. Supply fan operation will be monitored at the Plant's CCS, both running and overload will be monitored.
4. Equipment Set Points / Ranges:

<table>
<thead>
<tr>
<th>Device</th>
<th>Set Point / Range - Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential Pressure Transmitter</td>
<td>TBD</td>
</tr>
</tbody>
</table>

### 3.5 LIFT PUMPS

**A. General:**
1. Both pumps will be interlocked to prevent running by Normally Open contacts in both LIT-100 and LIT-101.
   a. When in MAINTENANCE mode, as selected at the Pump Control Panel (PCP) by a two position selector switch, the low level interlock shall be bypassed.

**B. Monitoring and Control:**
1. Field Instrumentation and Controls:
   a. Lift Pump #1.
   b. Lift Pump #2.
2. Motor - Controls:
   a. Both pumps shall have control pilot device at the PCP as indicated in the drawings.
   b. When in HAND mode, the pump shall start.
   c. When in OFF mode, the pump shall turn off.
   d. When in AUTO mode, the pump shall be started and stopped by the CCS.
   e. When the lift station is in LOCAL mode, the pumps shall be started and stopped in a lead/lag sequence by the dry contacts in LIT-100.
   f. When the high level alarm from LIT2 starts the pumps, pumps shall remain on until reset.
3. Computer Control System - Controls:
   a. Computer Automatic Control:
   b. Ultrasonic Level Sensor 1 and 2.
   1) Two ultrasonic level sensors, LIT1 and LIT2, (or MR1 & MR2) monitor level in the wetwell and transmit 4-20mA level signals to the PLC for monitoring and control. PLC uses only LIT or MR1 for pump control.
   2) LIT1 provides primary lift station control based on the 4-20mA level signal provided to the PLC. PLC logic operates the lift station sewage pumps based on Stop pump, start pump, and high level alarm. If level in the wetwell rises to the high level alarm as measured by LIT2, the lift station sewage pumps will automatically be placed into backup mode. This is done with control relays.
   3) LIT2 provides backup lift station control based on hardwired device contacts. The 4-20mA level signal is provided to the PLC.
for monitoring. The following hard wired device contacts for lift station sewage pump operation are provided from the level sensor: stop pump, start pump, and high level alarm. If level in the wetwell rises to the high level alarm, an alarm is sent to the autodialer and a red high level light on the panel will turn on. The setpoints for LIT2 will be set in the LIT2.

c. Pumps 1, 2.

1) **Normal Operation:** The pumps will be started and stopped by the PLC based on level in the wetwell reported to the PLC by LIT1. Pump start and stop levels can be set at the LCP-PLC cabinet through a laptop connection to the PLC. As liquid level rises, the main pump will be started at the ‘start pump’ level. The pump will continue to run until wetwell level drops to the ‘stop pump’ level.

2) **Backup Operation:** A high level alarm condition or manually switching hand switch HS-141 on LCP-PCP from the ‘PLC’ position to ‘MR2’ position will place the sewage pumps into backup operation. The pumps will be started and stopped by hard wired contacts from LIT2. Pump start and stop levels can be set at the LIT2 using the manufacturer provided ultrasonic level sensor programming device. As liquid level rises, the main pump will be started at the ‘start pump’ level. The pump will continue to run until wetwell level drops to the ‘stop pump’ level. The sewage pumps will remain in backup mode until the high level alarm reset pushbutton is pressed.

4. Equipment Set Points / Ranges:

<table>
<thead>
<tr>
<th>Device</th>
<th>Set Point / Range - Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEAD PUMP ON</td>
<td>8 ft</td>
</tr>
<tr>
<td>LEAD PUMP OFF</td>
<td>6 ft</td>
</tr>
<tr>
<td>LAG PUMP ON</td>
<td>9 ft</td>
</tr>
<tr>
<td>LAG PUMP OFF</td>
<td>6.5 ft</td>
</tr>
</tbody>
</table>

++ END OF SECTION ++
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 17001, Process Control System General Requirements for Process Instrumentation.

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 specified in Section 17001, Process Control System General Requirements for Process Instrumentation, and the detailed Specifications herein.
2. Field supervision, inspection, and start-up in accordance with the requirements of Section 17001, Process Control System General Requirements.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 17001, Process Control System General Requirements for Process Instrumentation.
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 17001, Process Control System General Requirements for Process Instrumentation.

1.5 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:

<table>
<thead>
<tr>
<th>PROCESS FLUID</th>
<th>ELASTOMER</th>
<th>METAL</th>
<th>PLASTIC</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td></td>
<td>Type 316 SS</td>
<td>Teflon</td>
<td></td>
</tr>
<tr>
<td>Alum</td>
<td>Buna-N</td>
<td>Type 316 SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td></td>
<td>Type 316 SS</td>
<td>Teflon</td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td>Buna-N</td>
<td>Type 316 SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Sump Drainage</td>
<td></td>
<td></td>
<td>Teflon Polypropylene</td>
<td></td>
</tr>
<tr>
<td>Chlorine Gas or Liquid</td>
<td>Viton</td>
<td>Hastelloy C, Monel, or Tantalum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digester Gas</td>
<td>Viton</td>
<td>Alloy C276</td>
<td>Type 316 SS</td>
<td></td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td></td>
<td>Tantalum</td>
<td>Teflon</td>
<td>Ceramic</td>
</tr>
<tr>
<td>Fluoride</td>
<td>Viton</td>
<td>Hastelloy C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycerine Oil</td>
<td>Neoprene</td>
<td>Type 316 SS</td>
<td>Teflon Polypropylene</td>
<td>PVC/CPVC</td>
</tr>
<tr>
<td></td>
<td>Viton</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Buna-N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halocarbon</td>
<td>Neoprene</td>
<td>Type 316 SS</td>
<td>Teflon</td>
<td></td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>Viton</td>
<td>Tantalum Zirconium Platinum</td>
<td>Teflon</td>
<td>Ceramic</td>
</tr>
<tr>
<td>Lime</td>
<td></td>
<td>Type 316 SS</td>
<td>Teflon</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td></td>
<td>Type 316 SS</td>
<td>Teflon</td>
<td></td>
</tr>
<tr>
<td>Non Potable Water</td>
<td>Neoprene</td>
<td>Type 316 SS</td>
<td>Teflon</td>
<td>Ceramic</td>
</tr>
<tr>
<td>PROCESS FLUID</td>
<td>ELASTOMER</td>
<td>METAL</td>
<td>PLASTIC</td>
<td>OTHER</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------</td>
<td>------------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Odor Control Scrubber Solution</td>
<td>Platinum</td>
<td>Teflon</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>Polymer</td>
<td>Buna-N</td>
<td>Type 316 SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium Permanganate</td>
<td>Viton</td>
<td>Carpenter 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw Sewage</td>
<td>Viton</td>
<td>Type 316 SS</td>
<td>PTFE</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>Sodium Chloride</td>
<td></td>
<td>Teflon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>Hastelloy B</td>
<td>Zirconium</td>
<td>Teflon</td>
<td>PVC/CPVC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Platinum</td>
<td>Polypropylene</td>
<td></td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td>Hastelloy C</td>
<td>Tantalum</td>
<td>Teflon</td>
<td>PVC/CPVC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Titanium</td>
<td>Polypropylene</td>
<td>Kynar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Platinum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silicone Oil</td>
<td>Viton</td>
<td>Buna-N</td>
<td>Teflon</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>Sludge</td>
<td>Neoprene</td>
<td>Buna-N</td>
<td>PTFE</td>
<td>Ceramic</td>
</tr>
</tbody>
</table>

### 1.6 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 01630, Computerized Maintenance Management System Tags.

### 1.7 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; 0.049 wall thickness.
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.
   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 A269, .049 wall thickness.
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.
   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 A312) and threaded fittings and adapters (ASTM A403) in accordance with Section 15103, Stainless Steel Pipe.
   b. Sizes: 1/2-inch minimum for main sensing piping and 1/4-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 15050, Piping Systems.
   d. Accessories:
      1) For applications not requiring diaphragm seals, provide separate 1/4-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 15115, 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 15105, Copper Pipe. CPVC pipe and fittings shall be provided in accordance with the requirements of Section 15106, 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 15050, Piping Systems.
   d. Accessories:
      1) For copper piping system taps with or without seals, provide a separate 1/4-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 15113, 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; ±0.005 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 ±0.0015 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 0.5 ms 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.
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:
   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 conduit 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 meet 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.

3. Pressure Rating: Greater than or equal to test pressure specified in Section 15050, 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.
c. End Connections: Flanged.
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. Series IFC Magnetic Flow tube and Signal Converter, as manufactured by Krohne America Incorporated.
   2. Series Watermaster Magnetic Flow tube Signal Converter, as manufactured by ABB/Fischer and Porter.
   3. Series Promag 400L Magnetic Flow tube and Signal Converter, as manufactured by Endress + Hauser.

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.
   7. Mounting: Wall/Ceiling: Provide appropriate brackets and appurtenances.
   8. Decibel Output: 100 at ten feet minimum with manual volume control.

D. Product and Manufacturer: Provide one of the following:
   1. NEMA 4X Rated: 400 ST/350.

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.
   7. Positive overrange protection of at least 1.25 times the maximum span limit.
   8. Calibration Adjustments:
      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.
   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:
      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.
   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. EJA Series, as manufactured by Yokogawa.
   2. 3051 Series, as manufactured by Rosemount, Incorporated.
   3. 900 Series, as manufactured by 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. 1981 series, as manufactured by Ametek U.S. Gauge.
   2. Series 34, as manufactured by 3D Instruments, Inc.
   3. 1279, as manufactured by Ashcroft.
   4. Or Equal

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 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 mA, Plus Hart digital signal.
      b. Digital process variable signal superimposed on 4 to 20 mA 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:
      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.


12. Electrical Connection 1/2-inch – NPT with side cover

13. Supply Voltage: 24 VDC - Transmitter operations between 11.5 to 36 Volts DC.

14. Process Connection: Threaded ANSI MNPT 1-1/2-inch 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 20 mA 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.


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: 1/2-inch 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 15050, 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. Type SGT, as manufactured by Mansfield & Green (for low pressures).
   2. Type L, as manufactured by Ametek.
   3. Type 201, as manufactured by Ashcroft.

2.3 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 01783, 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. The following shall constitute the minimum spare parts: PI-111, FE-105, FIT-105, PDIT-150, PI-151.

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 17001, Process Control System General Requirements for Process Instrumentation.
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 17053 – Process Control System Instrument Index 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 17001-B - Calibration Test Data Form as provided in Specification 01331 – 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 01821, Instruction of Operations and Maintenance Personnel. The services of equipment manufacturer's representatives shall be provided for a minimum of 2 hours for each type of the following instruments.
      a. Magnetic Flowmeters.
   2. Training shall accomplish the following:
      a. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance and equipment calibration.

++ END OF SECTION ++
SECTION 17053

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 17001 - Process Control System General Requirements for Process Instrumentation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
# INSTRUMENT INDEX

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SECTION 17226

PROCESS CONTROL SYSTEM 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)

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| DIGITAL INPUTS | 22 |
| DIGITAL OUTPUTS | 5 |
| ANALOG INPUTS | 8 |
| ANALOG OUTPUTS | 0 |
| TOTAL | 36 |
SECTION 17260

CONTROL PANELS

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 17051, 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. 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. ITPs 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.
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.
   4. ASTM International (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 LCPs and MCPs 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 Electric.
   2. Keller Electric Industries, Inc.
   3. Felix Construction
   4. Industrial Power Solutions, Inc.

1.5 SUBMITTALS

A. General:
   1. Reference Section 01330 Submittals.
   2. Panels shall be furnished in accordance with the requirements as shown on the Drawings, and as specified in Division 16, Section 16050, and Division 17000, Sections 17001, 17051, 17052, 17053, 17226 and 17260.
   4. Submit legible hard copies of the panel drawing package printed on 11-inch x 17-inch sheets.
   5. Submit manufacturer's technical data sheets and product literature for the panel and all components utilized. Clearly 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.
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 01781, 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 01651, Transportation and Handling of Materials and Equipment.
B. Comply with the requirements of Section 01661, Storage of Materials and Equipment.
C. Provide a hard copy of the panel drawings, size 11-inch x 17-inch, inside the panel upon delivery.

PART 2 - PRODUCTS

2.1 PANEL ENCLOSURES

A. General:
   1. Conform panels and enclosures to the NEMA requirements as stated in Specification 16050 – General Requirements.
   2. All outdoor panels shall be provided with sunshade structures. Sunshade structures 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 panels to provide a minimum of 25% 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-inch x 12-inch print pocket in panels with a 24-inch or larger door. Mount on inside door where no door mounted devices are located. If there is not enough room for a 12-inch x 12-inch 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.

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.
         1) None.
      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 Equal.
2. 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 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-inch 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) Gorilla Glue.
         2) Or Equal.
   4. Provide nameplates according to Table 2.1.C.5 and Section 3.1.B:

<table>
<thead>
<tr>
<th>Nameplate Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>Manufacturer Nameplate</td>
</tr>
<tr>
<td>Panel Nameplate</td>
</tr>
<tr>
<td>Device Nameplate</td>
</tr>
</tbody>
</table>

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 Equal.
         2) Provide device label size and fonts per Table 2.2.B.1:

<table>
<thead>
<tr>
<th>Device</th>
<th>Label Size</th>
<th>Font Size</th>
<th># Points</th>
<th>Brady Part #</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Wireways) 24VDC</td>
<td>1&quot;x 4&quot;</td>
<td>Arial</td>
<td>48 Points</td>
<td>PTL-42-422</td>
</tr>
<tr>
<td>(Wireways) 120VAC</td>
<td>1&quot;x 4&quot;</td>
<td>Arial</td>
<td>48 Points</td>
<td>PTL-42-422</td>
</tr>
<tr>
<td>Misc. Device Labels</td>
<td>1&quot;x 1&quot;</td>
<td>Arial</td>
<td>16 Points</td>
<td>PTL-19-423</td>
</tr>
<tr>
<td>Panel Door Devices</td>
<td>1&quot; x 1.5&quot;</td>
<td>Arial</td>
<td>8 Points</td>
<td>PTL-31-423</td>
</tr>
</tbody>
</table>

| 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 Equal.

D. Control Circuit – Supplementary Protectors:
   1. Provide single pole supplementary circuit protectors with the following features, 120 VAC, DIN rail mounted and UL 1099 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, NCIV-XXXXX-XXAA.

E. Air Conditioner or Heater Supplementary Protectors:
   1. Provide supplementary protectors with the following features, 120 VAC, DIN rail mounted and UL 489 listed with auxiliary contacts.
   2. Product and Manufacturer, Provide one of the following:
      b. Or 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. Relays shall not have an LED indicator.
   3. Product and Manufacturer: Provide one of the following:
      a. Type R and/or Type K, as manufactured by Square D Company.
      b. Type RH and/or Type RY, as manufactured by IDEC.
      c. Potter & Brumfield.
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. Series 328E, as manufactured by Automatic Timing and Controls Company.
      b. Series RTE as manufactured by IDEC.

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.

I. 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.
J. 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 equal.
      f. Panels conform to the wire color code as shown in Table 2.2.K.1.f Wire
         Color Code and NFPA 79 Standards.
   2. Product and Manufacturer: Provide one of the following:
      a. Carol.
      b. Belden.
      c. Anixter.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FUNCTION</th>
<th>INSULATION COLOR</th>
<th>WIRE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC POWER - HOT</td>
<td>120VAC</td>
<td><strong>BLACK</strong></td>
<td>#14</td>
</tr>
<tr>
<td>AC POWER - NEUTRAL</td>
<td>120VAC</td>
<td>WHITE</td>
<td>#14</td>
</tr>
<tr>
<td>AC GROUND</td>
<td>120VAC</td>
<td>GREEN</td>
<td>#14</td>
</tr>
<tr>
<td>AC CONTROL</td>
<td>120VAC</td>
<td><strong>RED</strong></td>
<td>#16</td>
</tr>
<tr>
<td>ISOLATED DC GROUND</td>
<td>GROUND</td>
<td>GREEN W/YELLOW</td>
<td>#16</td>
</tr>
<tr>
<td>DC POWER</td>
<td>SOURCE</td>
<td>BLUE</td>
<td>#16</td>
</tr>
<tr>
<td>DC POWER</td>
<td>COMMON</td>
<td>WHITE/BLUE</td>
<td>#16</td>
</tr>
<tr>
<td>CONTROL</td>
<td>FOREIGN VOLTAGES</td>
<td>ORANGE</td>
<td>#16</td>
</tr>
<tr>
<td>LOW VOLTAGE AC</td>
<td>24 VAC SOURCE</td>
<td>BROWN</td>
<td>#16</td>
</tr>
<tr>
<td>LOW VOLTAGE AC</td>
<td>24 VAC COMMON</td>
<td>BROWN W/WHITE</td>
<td>#16</td>
</tr>
<tr>
<td>*AC POWER</td>
<td>480 VAC PHASE A</td>
<td>BROWN</td>
<td>Size to FLA</td>
</tr>
<tr>
<td>*AC POWER</td>
<td>480 VAC PHASE B</td>
<td>ORANGE</td>
<td>Size to FLA</td>
</tr>
<tr>
<td>*AC POWER</td>
<td>480 VAC PHASE C</td>
<td>YELLOW</td>
<td>Size to FLA</td>
</tr>
<tr>
<td>TEMPORARY</td>
<td>TEMPORARY</td>
<td>PURPLE</td>
<td>Size to FLA</td>
</tr>
</tbody>
</table>

Table 2.2.K.1.f Wire Color Code

* - For Motor Control Panels (MCPs) 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.
K. 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.

L. 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.

M. 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.

N. 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 17262 – 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 Equal.

O. 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 Equal.

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 3-1/2-inch center to center and 3-1/2-inch 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-foot-0-inch from the floor. Minimum height for panel exterior-mounted devices is 3-foot-0-inch from the floor.
   5. Locate alarm horn at the top of the panel. The alarm horn may be located above 6-foot-0-inch 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.
         1) The first line indicates the name of the manufacturer, location and phone number of who assembled the panel.
         2) The following lines:
            a) Include panel voltage, current, phase, frequency, short circuit current rating for each panel feed.
            b) Provide switchboard name and circuit number for each circuit feeding the panel.
            c) 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)

3. Panel Identification Nameplate (NP-2):
   a. Mount panel identification nameplate in the top, center of the panel.
   b. Provide the following information:
      1) The first line of text is an abbreviation of the panel as shown on the CONTRACT DRAWINGS.
      2) The second line of text on the nameplate is used to spell out the process abbreviation.
      3) Refer to figure 3.1.B.3.

Figure 3.1.B.3

Panel Identification Nameplate (NP-2)

4. Panel Component Nameplates
   a. Mount nameplates above all control and indicating devices.
   b. Provide the following information:
      1) The first line indicates the instrument device loop identifier and number as shown on the DRAWINGS.
      2) The second line identifies the system equipment that the component is associated with.
      3) The third line identifies the control position, condition of the equipment or the alarm state being monitored.
      4) Refer to 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-inch clearance from any device or wireway to allow room for routing of field wiring.
   2. Concrete Pad or Floor Mounted LCPs – Where conduits enter the panel through the concrete pad, maintain a minimum of 6-inch 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-inch clearance from any device or wireway to allow room for routing of field wiring.
   3. Elevated Floor Mounted LCPs - Where conduit enters the panel, maintain a minimum of 4-inch clearance from any device or wireway to allow room for routing of field wiring.
   4. Concrete Pad, Floor Mounted or Elevated Floor Mounted ITPs - Where conduits enter the panel through the top or bottom, maintain a minimum of 6-inch 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-foot 0-inch 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 inches 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 16061 – Grounding Systems.

![Figure 3.2](image_url)

**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 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 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 inches beyond the tallest wireway between the analog and discrete wireways.

H. Wireways:
1. Mount wireways from the internal panel 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 panel.
4. Align wireways between back and side panels.
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.
7. In addition to the above requirements, for ITPs, wireways are not to be common for two terminal strips. Each terminal strip shall have a dedicated wireway on each side of the strip.

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 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.
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:
   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.
   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.
   b. Utilize the border and title block as provided in the Drawing Templates referenced in Section 3.3.A.1.

B. Panel Drawing Types:
1. General:
   a. Provide a complete documentation package for each panel consisting of the drawings in the order listed in Section 3.3.A.3.
2. 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.
3. 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.

4. Front Elevation Drawing:
   a. The Front Elevation drawing illustrates the arrangement of the panel and position of the devices on the front face of the panel.
   b. 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.
   c. Provide the nameplate schedule on the Front Elevation drawing.
   d. 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.
   e. Provide air conditioning heating and cooling information as provided by the Hoffman Temperature Calculation tool at: http://www.hoffmanonline.com/product_catalog/tools/index.aspx?cat_1=34&cat_2=375&SelectCatID=375&CatId=375

5. Interior Sub Panel Layout:
   a. General:
      1) The Interior Sub Panel Layout drawing identifies the individual interior components and their physical location.
      2) Draw all components within the panel to scale.
      3) Include all interior sub panels if the panel has sub panels on the side walls.
   b. 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 to drawing clutter.
      1) Bill of Materials:
         a) Include the devices on the Front Panel Elevation and the Interior Sub Panel(s) Elevation.
         b) 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.
         c) The utilization or insertion of Microsoft Excel files for the Bill of Materials is not allowed.
      2) Fuse Schedule.
      3) Supplementary Protector Schedule.
   c. Label and identify all devices, including terminal strips, relays, fuses, timers, power supplies and other special components on the drawing.
d. For unique devices not shown on the Symbols and Legend Sheets, use rectangles and squares with the appropriate dimensions of the device.

e. 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.

6. Terminal Strip Drawing:
a. General:
1) Terminal Strip Drawings provides locations for wiring terminations from field devices and other equipment external to the panel.
2) 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.
3) There are 5 different types of terminal strips and each has a specific function. The following is a brief description of each:
   a) For LCPs and MCPs:
      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 (RTDs). Identify terminal block number with consecutive numbers starting with number 1. The shield wire terminal block is to be label "SH".

b) For ITPs:
   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.
4) It is acceptable, if space available, to combine TB1, TB2, ATB and PTB on a single terminal strip drawing.
5) Identify spare terminals with an "SP" inside the rectangle.
6) Display terminals in the order they appear in the panel.
7) 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 "Xs" where wire tag normally resides. Provide this information prior to final deliverable of the Operations & Maintenance Manuals.
8) 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.

7. Control Schematic:
   a. General:
      1) Control Schematics show the controls associated with pieces of process equipment and provide a visual depiction of the majority of control wiring.
   b. Control Schematic Components:
      1) 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 inches.
         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 LCPs:
            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.


e) Power layout for MCPs:
   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 LCPs

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-inch 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#.

5) 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.

6) 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.
7) 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.

8) 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.

9) 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.

10) Push Buttons:
a) Represent the push button contact in its "off the shelf" state.

11) 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.

12) 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-inch 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. 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 120 VAC and 24 VDC power requirements.
13) 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.

8. 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.

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 03300, 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 05051, 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 incorporates these deviations into the final Operation & Maintenance Manual.

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 01783, 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 17001, 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 01331 – Reference Forms – Form 17260-A shall be utilized to document the test.
   1. The following is a list of panels that require the Factory Acceptance Test to be witnessed by ENGINEER and OWNER:
      a. None.
   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 two 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 two 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: 2 years.

++ END OF SECTION ++
SECTION 17262

PROGRAMMABLE LOGIC CONTROLLER, 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, 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 17051 – Computer Control System Process Control Descriptions and depicted on CONTRACT DRAWINGS.

C. Install and wire all Inputs/Outputs (I/O) as specified in Section 17260 – Control Panels.

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 DEFINITIONS

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: PLCs, OITs, networking hardware, software, programs, and accessories must comply with applicable provisions of the following, except where otherwise shown or specified.
   3. Institute of Electrical and Electronics Engineering (IEEE).
   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. 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.
1.5 SUBMITTALS

A. Submittals:
   1. The PLC submittal requirements are to be submitted with the control panel submittal package. Reference Section 17260 – Control Panels.
   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 each 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 17051 – Process Control Description.
      b. Attendees:
         1) PROGRAMMER/CONTROL PANEL SUPPLIER
         2) CONTRACTOR
         3) OWNER
         4) ENGINEER
   2. Conduct a minimum of a 4 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 3 hard copies and 3 soft copies of all OIT screens and PLC programming with addressing, comments, and descriptions at a minimum of 3 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 01781 – 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 M340 PLCs at the water and wastewater plants. Utilize M580 PLCs at SCADA and Lift Station remote sites because of the M580’s upgraded security properties, or if the following limitations occur.
   a. Large memory systems.
   b. Remote I/O.
   c. Hot Standby or Redundancy.
2. Provide PLCs with the following functionality:
   a. All operational, protective, status, and alarm functions as described per Section 17051 – Process Control Description, 17260 – Control Panels 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 17260 – Control Panels.

5. Meet the following for PLCs utilizing Ethernet protocols:
   a. Protocols that are assigned to port 502 of the transmission control protocol/internet protocol (TCP/IP) stack by the Internet Assigned Numbers Authority (IANA).
   b. 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.
   c. Provide an Ethernet networking connection either built into the central processing unit (CPU) or via an Ethernet networking module.
   d. Provide all equipment from non-third party vendors to meet the above criteria.

6. Virtual private network (VPN) access is NOT granted for offsite configuration, programming, troubleshooting, testing, and/or support.

B. M340 PLCs:

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 that do not have an integrated Ethernet port:
      1) BMX NOE 0100H.
      2) BMX NOE 0110H.
   b. Provide the following Serial Module for M340 PLCs:
      1) BMX NOM 0200H.

5. Communication Standards:
   Provide the following additional communication capabilities for M340 PLCs with an Ethernet port:
   a. ModbusTCP/IP.
6. Modules: Provide the following modules as needed to meet the requirements of the CONTRACT DOCUMENTS:
   a. Analog Inputs Modules:
      1) BMX ART 0414H.
      2) BMX ART 0814H.
      3) BMX AMI 0410H.
   b. Analog Outputs Modules:
      1) BMX AMO 0210H.
   c. Mixed Analog Modules:
      1) BMX AMM 0600H.
   d. Discrete Inputs Modules:
      1) BMX DDI 1602H.
      2) BMX DAI 1604H.
   e. Discrete Outputs Modules:
      1) BMX DDO 1602H.
      2) BMX DDO 1612H.
      3) BMX DAO 1605H.
   f. Mixed Discrete Modules:
      1) BMX DDM 16022H.
   g. Application Specific Modules:
      1) BMX EHC 0200H.
      2) BMX EHC 0800H.

7. The following types of terminals and wiring systems are permitted:
   a. If removable I/O module terminal blocks are used for terminating wires to the module, provide screw clamp terminal blocks (BMX FTB 2000).
   b. Provide pre-formed wiring cable as necessary, permitted all wires from the pre-formed cable are terminated to individual terminal blocks and are connected to field wiring.
   c. Provide Advantys Telefast wiring in conjunction with screw type Advantys Telefast ABE7 sub-bases as necessary.

C. M580 PLCs:
   1. Provide one of the following Modicon M580 CPUs:
      a. BME P58 2020H
      b. BME P58 2040H
   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.
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 01661 – Storage of Materials and Equipment, all unpopulated I/O modules.
   2. Use the following criteria when calculating the spare I/O:
      a. Analog Inputs (AI): 10% spare AI required.
      b. Discrete Inputs (DI): 25% spare DI required.
      c. Discrete Outputs (DO): 25% spare DO 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 is 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.
         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 17260 – Control Panels requirements, ensure all thermocouples and resistive temperature devices (RTD) are wired directly to the PLC.
2. Pre-formed wiring and Advantys Telefast harnesses are permitted.
3. Wiring spare I/O is not permitted, unless Advantys Telefast wiring and Advantys 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.
      2) Storage: 0-9,800 feet minimum.
   d. Degree of protection: NEMA 1 (IP20).
   e. 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.
   f. Shock resistance: 147m/s² for 11ms.

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 a battery backed 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.

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.
      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 applications utilizing Unity Pro version 11.

2.3 PLC PROGRAMMING

   A. 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 17051 – Computer Control System 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 11 paper.

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.

B. 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. DFBs 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 DFBs 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.

C. PLC and I/O health status:
1. Provide a programming section that monitors the status of the processor and attached I/O modules.

D. 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.

E. Naming Convention for Programming Sections: Provide each programming section with a short descriptive name, including an underscore as a space between words and using mixed case.
   1. The following names are acceptable:
      a. CfgAnalog
      b. Filter_Backwash
   2. The following names are NOT acceptable:
      a. FILTERBACKWASH (all caps)
      b. SectionOne (not descriptive)

F. Programming Sections: 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.
   1. PLC Status.
   2. Communication.
   3. Alarms.
   4. DI Mapping.
   5. AI Mapping/Scaling.
   7. Valve Control Sections.
   8. Motor Control Section.
   10. DO Mapping.
   11. AO Mapping/Scaling.

G. Program Addressing: Utilize the following standards for all programming addressing.
   1. Addressing Scheme
### Variable Type

#### Discrete Inputs/Reads

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Data Type</th>
<th>Address Range</th>
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</thead>
<tbody>
<tr>
<td>Physical DI's</td>
<td>T_DIS_IN_GEN</td>
<td>%CH...</td>
</tr>
<tr>
<td>Module Status</td>
<td>T_GEN_MOD</td>
<td>%CH...MOD</td>
</tr>
<tr>
<td>From RTU/Field Device/CCS</td>
<td>EBOOL</td>
<td>%M001 - %M199</td>
</tr>
<tr>
<td>From OIT</td>
<td>EBOOL</td>
<td>%M800 - %M999</td>
</tr>
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</table>

#### Discrete Outputs/Writes

<table>
<thead>
<tr>
<th>Group Description</th>
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<tr>
<td>Physical DO's</td>
<td>T_DIS_OUT_GEN</td>
<td>%CH...</td>
</tr>
<tr>
<td>Module Status</td>
<td>T_GEN_MOD</td>
<td>%CH...MOD</td>
</tr>
<tr>
<td>PLC Hardware &amp; Process Alarms</td>
<td>EBOOL</td>
<td>%M200 - %M399</td>
</tr>
<tr>
<td>To RTU/Field Device/CCS</td>
<td>EBOOL</td>
<td>%M400 - %M799</td>
</tr>
<tr>
<td>To OIT</td>
<td>EBOOL</td>
<td>%M1000 - %M1199</td>
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<tr>
<td>PLC Internal</td>
<td>EBOOL</td>
<td>%M1200 - %M1999</td>
</tr>
<tr>
<td>Other</td>
<td>EBOOL</td>
<td>%M2000 - %M...</td>
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</table>

#### Analog Inputs/Reads

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Data Type</th>
<th>Address Range</th>
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</thead>
<tbody>
<tr>
<td>Physical AI's</td>
<td>T_ANA_IN_BMX</td>
<td>%CH</td>
</tr>
<tr>
<td>Module Status</td>
<td>T_GEN_MOD</td>
<td>%CH...MOD</td>
</tr>
<tr>
<td>From RTU/Field Device/CCS</td>
<td>WORD</td>
<td>%MW001 - %MW199</td>
</tr>
<tr>
<td>From OIT</td>
<td>INT/UINT/DINT/UDINT</td>
<td>%MW1000 - %MW1199</td>
</tr>
<tr>
<td>From OIT</td>
<td>REAL/OTHER</td>
<td>%MW1200 - %MW1399</td>
</tr>
</tbody>
</table>

#### Analog Outputs/Writes

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Data Type</th>
<th>Address Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical AO's</td>
<td>T_ANA_OUT_BMX</td>
<td>%CH</td>
</tr>
<tr>
<td>Module Status</td>
<td>T_GEN_MOD</td>
<td>%CH...MOD</td>
</tr>
<tr>
<td>To RTU/Field Device/CCS</td>
<td>REAL/WORD</td>
<td>%MW200 - %MW999</td>
</tr>
<tr>
<td>PLC Internal</td>
<td>Any</td>
<td>%MW1400 - %MW1999</td>
</tr>
<tr>
<td>To OIT</td>
<td>INT/UINT/DINT/UDINT</td>
<td>%MW2000 - %MW2199</td>
</tr>
<tr>
<td>To OIT</td>
<td>REAL/OTHER</td>
<td>%MW2200 - %MW2399</td>
</tr>
</tbody>
</table>

Array Move to %MW Example Reading
Registers from Instrumentation or Power Monitoring then moving to %MW

2. 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.

H. Analog Scaling: 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.
I. Variable/Tag Names: 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.

J. Commenting: 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 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 follows:
   1. 5 Port Unmanaged Ethernet switch for LCP-PLC-LS.

C. Serial (RS-232, RS-422, and RS-485):
   1. 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. Install in the control panel all necessary cables and hardware that use Ethernet devices.
   2. Provide a DIN rail mounted Ethernet switch in control panels that have multiple Ethernet devices.
   3. All Ethernet switches are to be managed switches.
   4. Provide protocol and media converters as needed.

E. Fiber:
   1. None.

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, keys, 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: Provide a qualified service representative/programmer to perform the following:
   1. Inspect PLCs, wiring, components, connections, and equipment installation.
   2. 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 01782 – Record Documents.

3.7 SPARE PARTS:

A. Furnish and deliver spare parts and test equipment as outlined in Section 01783 – 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.
   2. Processors: Provide a minimum of one 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 one power supplies of a specific type installed.
   4. Memory Cards:
      a. Memory cards: If memory 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 spare backplanes.

3.8 TESTING AND ADJUSTMENTS:

A. Perform system testing and make any adjustments necessary in accordance with this section and Section 17001 – 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 17260 – Control Panels.
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 two 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 two trips to the site to perform the services as described under Section 01821 – Instruction of Operations and Maintenance Personnel. Coordinate each visit with the ENGINEER prior to arrival on the site.

D. All costs, including travel, lodging, meals, and incidentals for the CONTRACTOR and PROGRAMMER, are considered included in the CONTRACT price.

E. Warranty: 2 years.

++ END OF SECTION ++