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PROJECT NUMBER: WS85050051

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ATTACHMENTS

Attachment B - Reservoir Dam Assessment Program Specifications (Separate submittal prepared by others)
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DIVISION 1
GENERAL REQUIREMENTS
Part 1 - General

1.1 Location and Description of Work

A. The Work is located on the site of Reservoir 1-ES2-3 (aka. 24th Street Reservoir No. 3) located at the 24th Street Water Treatment Plant, Phoenix, Arizona.

B. The Contract Documents include the following:
   • Volume 1 of 3 Divisions 0 Through 1 Specifications
   • Volume 2 of 3 Divisions 2 Through 17 Specifications
   • Volume 3 of 3 Drawings

C. The Contract Documents for the Work to be performed include the following, but are not limited to:
   1. The rehabilitation efforts at Reservoir 1-ES2-3 (20 MG) include removal of the existing metal roofing system, removal of existing liner, repair to the existing shotcrete reservoir floor, removal of existing exterior piping, installation of a new polypropylene membrane liner, installation of new standing seam metal roofing system, replacement of the level transducer/transmitter, ventilation system improvements, replacing stairway hand rails, addition of ships ladders, walkways, equipment hatches, and roof openings, replacement of corroded hardware from the access door, removal of sack finish from the exterior ringwall, miscellaneous structural improvements for the roof structural framework. Miscellaneous site work includes corrosion removal work, signage improvements, vegetation removal along the reservoir embankment, and other work as indicated on the Drawings or described in the Specifications. The Work also includes miscellaneous electrical and instrumentation upgrades as indicated in the Drawings.

1.2 Contract

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

1.3 Work by Owner

A. OWNER will perform the following work:
   1. Operation of all existing system gates, valves and equipment, unless specified otherwise.
2. The OWNER will drain the reservoir to the depth specified on the plans (the CONTRACTOR will be responsible to drain the remaining water in the reservoir prior to starting work).

1.4 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 01111, Schedule of Completion, and 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.

1.5 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.

1.6 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.

1.7 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.

1.8 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”.
2. Existing ultrasonic level transducer/transmitter and appurtenances.
3. Existing anchor bolts to potentially be reused depending on pull test and ENGINEER recommendations.

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. Completion of certain activities are directly related to operation capacities at the Reservoir 1-ES2-3 Site. A Shutdown Schedule, consisting of all facility shutdowns, is included in Section 01143, Coordination with OWNER’S Operations.

D. 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 24th Street WTP Reservoir No. 3 (1-ES2-3) Rehabilitation Project shall be as follows:

<table>
<thead>
<tr>
<th>Areas</th>
<th>Work/Work Sequence</th>
<th>Completion Calendar Day/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir 1-ES2-3</td>
<td>All Work (Substantial Completion)</td>
<td>180 Calendar days; Reservoir in-service date is September 15, 2017</td>
</tr>
<tr>
<td>Reservoir 1-ES2-3</td>
<td>All Work (Final Completion)</td>
<td>30 Calendar days from date of substantial completion</td>
</tr>
</tbody>
</table>
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01112

PARTNERING

PART 1 - GENERAL

1.1 COVENANT OF GOOD FAITH AND FAIR DEALING

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

1.2 VOLUNTARY PARTNERING

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

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

C. To implement this partnering initiative prior to starting of Work in accordance with the requirements of Section 01110, Summary of Work, and prior to the Pre-construction Conference, CONTRACTOR’S management personnel and the OWNER will initiate a partnering development seminar/team building workshop. The ENGINEER will make arrangements to determine attendees at the workshop, agenda of the workshop, duration, and location. Persons required to be in attendance will be the OWNER, ENGINEER, and key project personnel, CONTRACTOR’S on-site Project Manager and other key project supervision personnel of both the principal subcontractors and suppliers. During the workshop, the participants shall develop and sign the Project Partnership Charter.
D. Follow-up workshops may be held periodically throughout the duration of the Work as agreed by CONTRACTOR, ENGINEER and OWNER.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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 operation of any adjacent facilities, Reservoir 1-ES2-1, Reservoir 1-ES2-2, and finished water booster pump station located within the 24th Street Water Treatment Plant (WTP) are maintained 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 facility 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 facility operation, compromise facility security, or create potential hazards to operating equipment and facility personnel. 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 anytime during normal work hours during the Contract period, subject to the operating requirements outlined in this Section. All references to days in this Section are consecutive calendar days.

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

F. 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 plant/facility operations and processes by limiting the number of shutdowns required.
G. Contractor shall not shut-off or disconnect any operating system, 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 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 plant/facility during construction activities. All pumps shall be provided with magnetic flowmeters capable of providing a 4 to 20 mA output signal. Man all pumps continuously (24 hours per day) when in service. Submit to the ENGINEER, for information only, the design for all temporary lines, pumping, or conveyance systems at least 14 days prior to the commencement of the Work.

J. Unless otherwise specified, dewater process tanks and pipelines at the beginning of each shutdown. Responsible for washing down and cleaning all tanks, basins, pipelines and other Work areas. Also for the removal of all washdown, cleaning and storm water that accumulates in the Work areas. Removal of material shall be included as a separate item on CONTRACTOR’S Schedule of Values.

1.2 GENERAL CONSTRAINTS

A. Article 1.3, below, and Section 01111, Schedule of Completion, specify the sequence and shutdown durations, where applicable, for plant/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 plant/facility site.
   1. Load limits on Access Roads: Existing and new underground facilities, such as electrical duct banks, pipelines, etc., in, under and crossing plant/facility roads, have been designed for a maximum wheel load of H20. Not exceed this weight limit and shall provide means of protecting the underground facilities.
2. Access to Plant Site: An unobstructed traffic route through all plant/facility gates shall be maintained at all times.

3. Safety Barriers: Place safety barriers around unsafe areas located around operational areas accessible to plant/facility Personnel.

4. Personnel Access: Treatment plant/Facility Personnel shall have access to all areas which remain in operation throughout the construction period.

5. Potable Water System: The existing potable water system shall be kept in operation at all times, unless otherwise specified in Article 1.3, below.

6. Plumbing Facilities: Sanitary facilities in the existing structures shall be operational at all times for plant/facility Operating Personnel, unless otherwise specified in Article 1.5, below. All other building plumbing systems, such as roof and floor drains, pumping, etc., shall be maintained for all structures.

7. Storm drainage: Storm drainage on the site shall be operational at all times, unless otherwise specified in Article 1.3, below.

8. 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.

9. 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.

10. Seal and Service Water Piping: A supply of service and seal water and the necessary connections to existing equipment shall be maintained during construction, unless otherwise specified in Article 1.3, below. Interim piping shall be provided by CONTRACTOR, as required.

11. The OWNER will assist CONTRACTOR in dewatering process tanks, basins and other plant process Work areas. It is CONTRACTOR’S responsibility to maintain a clean and dry Work area by pumping and properly disposing of all washdown and cleaning water and stormwater that accumulates in the Work areas.

12. Draining Pipes:
   a. Unless otherwise specified, the contents of pipes undergoing modifications shall be transferred to City’s sanitary sewer or process drain system as indicated by the City 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.

13. 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.

14. 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.

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

1.3 SHUTDOWNS

A. General:

1. A shutdown shall be defined as a portion of the normal operation of a plant unit/facility or reservoir supply line 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 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 2 weeks prior to the proposed start date.

2. The Work required herein and any other Work required by the ENGINEER which may interrupt the normal plant/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 plant in continuous satisfactory operation. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of the facilities that result in fines levied by the U.S. Environmental Protection Agency, Arizona Department of Environmental Quality, Maricopa County Health Department Bureau of Air Pollution Control, or the Maricopa County Department of Environmental Management shall be the responsibility of CONTRACTOR if it is demonstrated that CONTRACTOR was negligent in the Work or did not exercise proper precautions in the conduct of the Work.
5. The scheduled shutdowns during the period of CONTRACTOR’S Work will be as shown in Table 01143-A. All Work requiring the plant/facility to be out-of-service shall be performed during the scheduled shutdowns shown. It should be noted OWNERS’s staff shall continue to perform administrative, operation and maintenance functions during shutdowns.

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

<table>
<thead>
<tr>
<th>Area</th>
<th>Equipment</th>
<th>Constraints</th>
<th>Dates/Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir 1-ES2-3 Inlet/Outlet Lines</td>
<td>Storage Reservoir</td>
<td>No</td>
<td>Duration of the project construction (to substantial completion)</td>
</tr>
<tr>
<td>Reservoir 1-ES2-3</td>
<td>Storage Reservoir</td>
<td>No</td>
<td>Duration of the project construction (to substantial completion)</td>
</tr>
</tbody>
</table>

1.4 OVERTIME

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

1.5 MAINTENANCE OF PLANT OPERATIONS SCHEDULE

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

B. Within each MOPO item’s procedural steps, time and scheduling constraints and milestone dates may be outlined and are intended to assist CONTRACTOR in developing a sequence of Work and timing in order to maintain continuous operation of the plant.
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 plant 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 plant, gravity sewer and force main system shall be performed simultaneously in order to complete the entire scope of the Work within the allotted Contract time.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
### 1.0 SCHEDULE OF MOPO FOR RESERVOIR 1-ES2-3.

<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>Reservoir 1-ES2-3</td>
<td>Reservoir 1-ES2-1, Reservoir 1-ES2-2, Reservoir 1-ES2-3, and Finished Water Pump Station</td>
<td>Reservoir 1-ES2-1, Reservoir 1-ES2-2, and Finished Water Pump Station</td>
<td>Reservoir 1-ES2-3</td>
<td>Reservoir 1-ES2-1, Reservoir 1-ES2-2 and Finished Water Pump Station</td>
<td>CONTRACTOR shall: coordinate shut-down of Reservoir 1-ES2-3 and operation of Reservoir 1-ES2-1, Reservoir 1-ES2-2 and Finished Water Pump Station with OWNER</td>
<td>N/A</td>
<td>Duration of project construction (to substantial completion)</td>
</tr>
</tbody>
</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, plant services, CONTRACTOR’S or ENGINEER’S field offices, layout surveys, job signs, sanitary requirements, testing, safety devices, approval and Record Drawings, water supplies, power, traffic maintenance, removal of waste, watchmen, bonds, insurance, or all other requirements of the General Conditions, Supplementary Conditions, and the Contract Requirements. 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.
1.4 GENERAL – BASE BID ITEMS

A. Bid Item 1 – MOBILIZATION/DEMOBILIZATION:
   1. Mobilization/Demobilization pay item, as specified in the General Conditions of the bid document.

B. Bid Item 2 – DRAINING, PLUGGING, CLEANING, FILLING, TESTING AND DISINFECTION:
   Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
   1. Drain and dispose of remaining water from reservoir (bottom 6-feet).
      Include pumping equipment as necessary to pump remaining water to the location shown on drawings, at or below the maximum rate stated in the plan set.
   2. Install new inflatable pipe plugs at inlet and outlet piping inside the reservoir.
      a. Plugs to remain in place and maintained by CONTRACTOR until reservoir has passed disinfection and leak testing requirements.
   3. Pressure wash the existing liner and remove and dispose of existing debris covering the floor and sidewall surfaces.
   4. Cleaning of reservoir after completion of the rehabilitation work.
   5. CONTRACTOR to conduct hydrostatic and leak test.
   6. It may be necessary to remove and reinstall the plug to fill the reservoir and during hydrostatic testing.
   7. CONTRACTOR to conduct reservoir disinfection.
   8. The CONTRACTOR shall retain the services of a licensed commercial diver as needed to remove and reinstall the plug under submerged conditions.
   9. All work related to this bid item not specifically covered in other pay items.
   10. Provide all coordination with the OWNER and other agencies for discharge requirements.

C. Bid Item 3 – ROOF, LINER AND MISCELLANEOUS DEMOLITION:
   Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Demo existing galvalume roofing system, ridge cap, all fascia and flashing material, and all corresponding fastening screws and clips.
2. Remove all SST batten hardware inside reservoir and remove existing HDPE liner.
3. Remove miscellaneous items related with existing roofing and lining system.
4. Remove stilling well and corroded SST bands.
5. All work related to this bid item not specifically covered in other pay items.

D. Bid Item 4 – PRESSURE WASH:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Pressure wash interior framing, columns, and walls to remove staining or calcium deposits.
2. All work related to this bid item not specifically covered in other pay items.

E. Bid Item 5 – SANDBLASTING CORROSION ON STEEL:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Sandblast all areas of corrosion or peeling on girders, purlins, and base plates.
2. All work related to this bid item not specifically covered in other pay items.

F. Bid Item 6 – APPLICATION OF EPOXY COATING ON GIRDER AND PURLINS:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Apply 2 coats epoxy to areas on girders and purlins where corrosion was removed.
2. All work related to this bid item not specifically covered in other pay items.

G. Bid Item 7 – CONCRETE REPAIR:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to
meet the requirements defined in the Contract Drawings and Specifications for the following items:

1. Repair concrete spalling and exposed rebar.
2. Repair concrete spalls and where delamination has exposed underlying aggregate.
3. All work related to this bid item not specifically covered in other pay items.

H. Bid Item 8 – GROUT REPAIR:
Measurement and payment for this bid item shall be made at the UNIT COST (EA) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:

1. Remove all defective grout and clean and coat exposed metal at bearing locations.
2. Install new non-metallic, non-shrink grout and coat and seal to encapsulate entire bearing connection per recommendation.
3. All work related to this bid item not specifically covered in other pay items.

I. Bid Item 9 – INSTALL ADDITIONAL ANCHORS AND STIFFENER PLATES:
Measurement and payment for this bid item shall be made at the UNIT COST (EA) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:

1. Install additional anchors and stiffener plates at girder-to-wall connections.
2. All work related to this bid item not specifically covered in other pay items.

J. Bid Item 10 – NEW ROOF SYSTEM:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:

1. Install new aluminum standing seam roof deck, SST sliding clips, and all corresponding fasteners and components per the plans and specifications.
2. Install catwalks with new galvanized steel hardware to access equipment hatches.
3. Install 8’X12’ removable roof openings with fall protection, equipment hatches, and structural modification to the roof support system.
4. Install confined space entry warning labels on all equipment access hatches and door.
5. Provide galvanized steel ladders outside the reservoir to access roof from the ground level.
6. Install new “DO NOT WALK ON THE RESERVOIR ROOF” signs at each of the galvanized ladders.

7. All work related to this bid item not specifically covered in other pay items.

K. Bid Item 11 – RESERVOIR VENTILATION IMPROVEMENTS:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Install new ridge vents.
2. Replace mesh screen on existing eave vents.
3. All work related to this bid item not specifically covered in other pay items.

L. Bid Item 12 – RESERVOIR LINING SYSTEM:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Install membrane liner on the walls, bottom slab, and sideslopes of the reservoir and fasten to the existing concrete structure with Type 316 stainless steel batten strips and anchor bolts.
2. Provide industrial membrane coating as shown on the plan set.
3. All work related to this bid item not specifically covered in other pay items.

M. Bid Item 13 – RESERVOIR INTERIOR CRACKS/HOLE REPAIR AND ELASTOMERIC COATING:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Repair cracks at existing HDPE plate and coat with elastomeric coating.
2. Repair existing notch cracks and coat with elastomeric coating.
3. Repair existing core holes and coat with elastomeric coating.
4. All work related to this bid item not specifically covered in other pay items.

N. Bid Item 14 – REMOVE PIPING:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Remove piping and miscellaneous stub outs from reservoir west wall and embankment.
2. All work related to this bid item not specifically covered in other pay items.

O. Bid Item 15 – REPLACE ULTRASONIC LEVEL SENSORS AND MISCELLANEOUS IMPROVEMENTS:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Remove and replace ultrasonic level sensors with new ultrasonic level sensors, transmitter and Type 316 SST hardware.
2. Replace the corroded hardware on the reservoir main access door with new Type 316 stainless steel hardware.
3. Remove and replace existing light fixture and receptacle.
4. All work related to this bid item not specifically covered in other pay items.

P. Bid Item 16 – SANDBLASTING RESERVOIR RINGWALL AND MISCELLANEOUS IMPROVEMENTS:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Sandblast reservoir ringwall exterior to remove existing paint and sack finish.
2. Install identification tags on reservoir columns to facilitate future inspections and correlate results to the inspection grid.
3. Sandblast and remove corrosion from metal grills on reservoir overflow discharge structure and pipe stub-outs on reservoir ringwall and repaint with protective coating.
4. All work related to this bid item not specifically covered in other pay items.

Q. Bid Item 17 – MISCELLANEOUS ELECTRICAL AND INSTRUMENTATION IMPROVEMENTS:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Install new intrusion alarms on equipment access hatches and doors.
2. Install equipment sunshade structures.
3. Programming and misc. electrical.
4. New conduit and electrical work for additional hatches and security cameras.
5. All work related to this bid item not specifically covered in other pay items.

R. Bid Item 18 – MISCELLANEOUS ELECTRICAL AND INSTRUMENTATION DURING CONSTRUCTION:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Temporary conduit and electrical for security cameras during construction.
2. All work related to this bid item not specifically covered in other pay items.

S. Bid Item 19 – MISCELLANEOUS CIVIL AND SITE IMPROVEMENTS:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Repair chips and spalled concrete on the reservoir stairs.
2. Replace corroded railings on the reservoir stairs with Type 316 Stainless Steel railings with toe boards.
3. Remove debris and sediment from gutters, patch crack in access road.
4. All work related to this bid item not specifically covered in other pay items.

T. Bid Item 20 – LANDSCAPING REMOVAL:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Vegetation removal along reservoir embankment.
2. All work related to this bid item not specifically covered in other pay items.

U. Bid Item 20 THROUGH 24 – OWNER’S ALLOWANCES AND CONTINGENCY:
The Owner’s Allowances and contingencies set forth in the Bid Form shall be included in the CONTRACTOR’S bid to cover the cost of Unit Price Bid Item additions and modifications to the project as deemed necessary by the OWNER.
1. Owner’s allowance to provide/facilitate access for the Engineer for special inspection of purlins after the demolition of the existing roof.
2. Owner’s allowance for replacement of purlins following roof inspection.
3. Owner’s allowance for concrete spalling repair at reservoir foundation as required once existing liner is removed.
4. Owner’s contingency.

1.5 ALTERNATIVE 1 BID ITEMS

A. Alternative 1 Bid Item 1 – ROOF, LINER AND MISCELLANEOUS DEMOLITION:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Demo existing galvalume roofing system, ridge cap, all fascia and flashing material, and all corresponding fastening screws and clips.
2. Salvage all SST batten and hardware inside reservoir.
3. Remove existing HDPE liner.
4. Leave all nuts, washers and anchors in place.
5. Remove stilling well and corroded SST bands.
6. All work related to this bid item not specifically covered in other pay items.

B. Alternative 1 Bid Item 2 – RESERVOIR LINING SYSTEM:
Measurement and payment for this bid item shall be made at the UNIT COST (SF) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Install membrane liner on the walls, bottom slab, and sideslopes of the reservoir and fasten to the existing concrete structure with salvaged stainless steel batten strips and anchor bolts.
2. Provide industrial membrane coating as shown on the plan set.
3. All work related to this bid item not specifically covered in other pay items.

C. Alternative 1 Bid Item 3 – LANDSCAPING REMOVAL:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Vegetation removal along reservoir embankment.
2. All work related to this bid item not specifically covered in other pay items.
1.6 ALTERNATIVE 2 BID ITEMS

A. Alternative 2 Bid Item 1 – LANDSCAPING REMOVAL:
Measurement and payment for this bid item shall be made at the LUMP SUM (LS) cost provided in the Bid Schedule. This bid item shall include furnishing all labor, tools, equipment and materials, and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and Specifications for the following items:
1. Vegetation removal along reservoir embankment.
2. All work related to this bid item not specifically covered in other pay items.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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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 01320, 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 area:
   1. Demolition
   2. Roof Installation
   3. Liner Installation
   4. Ventilation
   5. Site Work
   6. Paintings and Coatings
   7. Structural Concrete Modifications and Repairs
   8. Electrical and Instrumentation

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 013202, Progress Schedule.

1.3 SUBMITTALS

A. Submit two copies of the Preliminary Schedule of Values to ENGINEER for review within 7 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)
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 7 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.

E. Utility company representatives.
1.3 PURPOSE

A. The purpose of the Pre-construction conference is to designate responsible personnel and establish working relationships. Matters requiring coordination will be discussed and procedures for handling such matters will be established. A complete agenda will be furnished to CONTRACTOR prior to the Pre-construction conference date. However, 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 ++
SECTION 01311

PROJECT COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

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

B. As more fully set forth in of the General Conditions, Cooperate with and coordinate the Work with the work of any other contractor, 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 ++
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SECTION 01312

PROGRESS MEETINGS

PART 1 - GENERAL

1.1 DESCRIPTION

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

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

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

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

1.2 MINIMUM ATTENDANCE

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

B. ENGINEER.

C. OWNER'S representative, if required.

D. Others, as appropriate.

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

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
1. Transcript of previous meeting.
2. Progress since last meeting.
   a. CONTRACTOR’S.
   b. Subcontractors’.
3. Completion status.
4. Planned progress for next period including a 3-week look-ahead schedule to include upcoming inspections.
5. Document and track to correction and closure any problems, conflicts, issues, and observations that are voiced by anyone of the project team.
6. Status of Shop Drawings, submittals, long lead items, RFI and RFAs.
7. Change Orders.
8. Pay Requests.
10. Schedules, updated Project Schedules, including off-site fabrication and delivery schedules; corrective measures, if required.
11. Coordination between parties.
13. Safety concerns.
15. Record Drawings.
16. Warranty Requests.
17. Punch List Status.
18. Other business.
19. Next meeting date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01320

PROGRESS SCHEDULE

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”.
   a. Submit for review within Ten (10) calendar days of Notice to Proceed.
   b. 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 + +
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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 25 per month.

B. Take a minimum of 75 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 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.
1.3 PRINTS

A. Provide high quality digital photographs on CDs. The file format shall be “.jpg”. Need to provide a file for all required under paragraph 1.2.A.

B. 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.

C. Place the following information on front for digital photographs:
   1. Date photograph was taken.
   2. Title of Project, WS #85050046.
   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 (Ph. #) must be notified before photos or videotapes are made.

3. Prior to departing from the site, photographer must have the materials reviewed by either the Facility Supervisor or the O&M Supervisor. For media that’s not readily viewable, such as film that needs to be developed, the photographer must allow the Facility Supervisor or O&M Supervisor to review the materials prior to any use of the materials.

B. General

1. It is the CONTRACTORS responsibility to provide 75 pre-construction photographs, 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 (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 ++
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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. Piecemeal 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 21 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 7 days after the Notice to Proceed: Submit the following items within 7 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 Values: Prepare and submit in accordance with Section 01291, Schedule of Values.
2. Preliminary Schedule of Shop Drawings and Sample Submittal in accordance with the General Conditions and Section 01332, Shop Drawing Procedures.
3. Preliminary Progress Schedule: Prepare and submit in accordance with Section 01320, Progress Schedule.

B. Submittal 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. Schedule of Values: Prepare and submit in accordance with Section 01291, Schedule of Values.
2. Submittal Schedule: Prepare and submit schedule of all Shop Drawings in accordance with Section 01332, Shop Drawing Procedures.
3. Monthly payment schedule.
4. Maintenance of Plant Operations Schedule, in accordance with Section 01143, Coordination with OWNER’S Operations.
5. Ninety-day Bar Chart Schedule: Prepare and submit a 90-day Bar Chart Schedule within 14 days, in accordance with Section 01320, Progress Schedule.

C. 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. Progress Schedule: Prepare and submit a Progress Schedule within 30 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 one hard copy and 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
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 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 7 days for ENGINEER’S review.

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)
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>
</tr>
</thead>
<tbody>
<tr>
<td>00800-A</td>
<td>Certificate of Substantial Completion</td>
</tr>
<tr>
<td>00800-B</td>
<td>Contractor’s Affidavit Regarding Settlement of Claims</td>
</tr>
<tr>
<td>01143-A</td>
<td>Extended Construction Work Hours Permit Application</td>
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<tr>
<td>01330-A</td>
<td>Schedule of Values</td>
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<tr>
<td>01330-B</td>
<td>Shop Drawings, Product Data and Sample Submittal Schedule</td>
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<td>01330-C</td>
<td>Authorized Signatures Form</td>
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<td>01330-D</td>
<td>Application for Payment</td>
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<td>01330-E</td>
<td>MBE/WBE Utilization Form</td>
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<td>01330-F</td>
<td>Request for Change Order Proposal</td>
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<td>01330-G</td>
<td>Change Order Proposal</td>
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<td>01330-H</td>
<td>Work Change Directive</td>
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<td>01330-I</td>
<td>Change Order Pricing Sheet</td>
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<td>01330-J</td>
<td>Change Order</td>
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<td>Request for Information</td>
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<td>01330-L</td>
<td>Request for Alteration</td>
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<td>01330-M</td>
<td>Contractor’s Daily Construction Report</td>
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<td>01330-O</td>
<td>Contractor Submittal Review Checklist</td>
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<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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<td>01415-A</td>
<td>Confined Space Data Sheet</td>
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<tr>
<td>01415-B</td>
<td>Confined Space Entry Permit</td>
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</tbody>
</table>
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

01415-C Confined Space Hot Work Permit
01600-A Equipment Information Form Instructions
01600-A 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
01781-A Operation & Maintenance Manual Review Checklist
01781-B Operations & Maintenance Manual Data Review Checklist
01783-A Spare Parts Receiver Form
01821-A Manufacturer’s Instruction Certification Form
01821-B Training Request Form
15142-A Request for Bacteriological Samples
16000-A Wire and Cable Resistance Test Data Form
16000-G Protective Relay Test Form
16000-H Low Voltage Switchgear Test Form
16000-I Medium Voltage Load Interrupter Switch Test Form
16000-J Liquid-Filled Transformer Test Form
16000-K Automatic Transfer Switch Test Form
16000-L Neutral Grounding Resistor Test
16000-M Conduit and Wire Termination Sheet
16000-N Ground Test Point Data Form
16215-A Power Study Coordination Form
16231-A Add Generator to Fleet – Inspection Checklist
17001-A Instrument Tubing Leak Test Form
17001-B Calibration Test Data Form.
17001-C Functional Acceptance Test
17260-A Factory Acceptance Test Report

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

Form 00800-A

CITY OF PHOENIX
WATER SERVICES DEPARTMENT
CERTIFICATE OF SUBSTANTIAL COMPLETION

<table>
<thead>
<tr>
<th>PROJECT NUMBER</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
</table>

DATE OF ISSUANCE: ___________  OWNER'S CONTRACT NO.: _______________

OWNER: ________________________

ENGINEER: ______________________

CONTRACTOR: ____________________

This Certificate of Substantial Completion applies to all Work under the Contract Documents or to the following specified parts thereof:

OVERALL PROJECT

To: CITY OF PHOENIX

OWNER

And to __________________________

CONTRACTOR

The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on

TYPE DATE HERE

DATE OF SUBSTANTIAL COMPLETION

A tentative list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of CONTRACTOR to complete all the Work in accordance with the Contract Documents. The items in the tentative list shall be completed or corrected by CONTRACTOR by Final Completion.

00800-A  NOVEMBER 2016
Contractor's Affidavit
Regarding Settlement of Claims

Project No.: ____________________  
Contract No.: ____________________  

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $____________ as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Phoenix against any and all liens, suits, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said installation.

________________________________________
Contractor

________________________________________
By

________________________________________
Title

State of __________________________________

County of __________________________________

The forgoing instrument was subscribed and sworn to before me this ___ day of ________, 20____.

________________________________________
Notary Public

Commission Expiration Date
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 [ ] □ Ext Hrs Permit Number _______ □ EXTH ________ □ EXTR ________

Date, Day(s) of Week, Hours ________________________________

Authorizing Signature __________________________ Phone __________________________ Date __________________________

Fee Collected $ ___________ Date Paid ___________ Receipt # ___________

Project Info: Project # __________________________ Permit Type/# _______ Qtr Section _______

cc: City Council District __________________________ Police Patrol Division ___________ Other ___________

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/DEVPROM/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.
Form 01330-A

SCHEDULE OF VALUES

Sheet ______ of ______

Section No. ____________

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Material</th>
<th>Labor</th>
<th>Equipment</th>
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</table>
CITY OF PHOENIX: Water Services Department  
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation  
PROJECT NUMBER: WS85050051

**Form 01330-B**

SHOP DRAWINGS, PRODUCT DATA AND SAMPLE SUBMITTAL SCHEDULE

<table>
<thead>
<tr>
<th>Item No.</th>
<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>
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01330-B   NOVEMBER 2016
Gentlemen:

WHEREAS, 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 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__.

NAME  SIGNATURE  TITLE   DOCUMENTS
_________________________  __________________________  __________________________  __________________________

I, __________________________, of the 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)

_________________________  __________________________  __________________________  __________________________

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)
**APPLICATION FOR PAYMENT**

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

**Progress Payment No. __**  
Payment Period: From mm/dd/yy to mm/dd/yy

<table>
<thead>
<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>
</tr>
</thead>
<tbody>
<tr>
<td>xxxxx</td>
<td>Xxxxxxxxxxxxxxxxxxxxxxxxxxxxx</td>
<td>$xx,xxx,xxx.xx</td>
<td>$xx,xxx,xxx.xx</td>
<td>$xx,xxx,xxx.xx</td>
<td>$xx,xxx,xxx.xx</td>
</tr>
</tbody>
</table>

** ATTACHMENTS: SCHEDULE OF VALUES **

- □ 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**

  **Project Manager/Engineer**  
  **Date**

**Firm**

---

**CITY USE ONLY BELOW THIS LINE**

**RECOMMENDED BY:**  
**APPROVED BY:**

**Project Manager**  
**Date**

**Superintendent**  
**Date**

---

**01330-D NOVEMBER 2016**
<table>
<thead>
<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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</thead>
<tbody>
<tr>
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<td>$xx,xxx,xxx.xx</td>
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<td>$xx,xxx,xxx.xx</td>
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</tr>
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</table>
### 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 ______________

<table>
<thead>
<tr>
<th>Project Number:</th>
<th>Project Description:</th>
<th>Base Bid Amount: $</th>
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</thead>
<tbody>
<tr>
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**Required Goals:**

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<th>MBE %</th>
<th>WBE %</th>
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<tbody>
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**Proposed Goals:**

<table>
<thead>
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<th>MBE %</th>
<th>WBE %</th>
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<table>
<thead>
<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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<tbody>
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</tbody>
</table>

**Minority Owned Business Enterprise Totals**

**Woman Owned Business Enterprise Totals**

---

**FOR CITY OF PHOENIX USE**

Percent of total project complete _________ %  **Date:** ______________

**City Project Manager**  ___________________________  **Signature**

---

**Authorized Signature:** ___________________________  **Date:** ______________

**Name and Title:** ___________________________

---

01330-E  NOVEMBER 2016
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:
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

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSXXXXXXX</td>
<td>NAME OF PROJECT</td>
</tr>
</tbody>
</table>

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-H NOVEMBER 2016
CHANGE ORDER PRICING SHEET

CITY OF PHOENIX - WATER SERVICES DEPARTMENT

PROJECT: WS85050051

01330-I  CHANGE ORDER PRICING SHEET

PREPARED BY: CITY OF PHOENIX - WATER SERVICES DEPARTMENT

01331-I

NOVEMBER 2016

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Quantity</th>
<th>Measure</th>
<th>Column S</th>
<th>11.4.2</th>
<th>11.4.3</th>
<th>11.4.4-11.4.5</th>
<th>11.6.2.3</th>
<th>11.6.2.4</th>
<th>Subtotal</th>
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</table>

COLUMN SUBTOTALS:  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00

11.6.2.1 Fee for work by Contractor:  15.00%  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00

11.6.2.5 Fee for net credit Change Order:  5.00%  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00

11.6.2.2 Fee for work by Subcontractor:  5.00%  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00

COLUMN TOTALS:  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00  $0.00

NOTES:
1. See Contract General Conditions Article 11.
2. Also submit CHANGE ORDER PRICING SHEET for Subcontract work listed above and exceeding $500.

ADJUSTMENTS

GRAND TOTAL CHANGE ORDER AMOUNT:  $0.00

TABLE 1 - Labor Rates

<table>
<thead>
<tr>
<th>P. Work Classification</th>
<th>Q. Base Hourly</th>
<th>R. Backen</th>
<th>S. Total Hourly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage Rate</td>
<td>Submit Dates</td>
<td>Rate</td>
<td></td>
</tr>
</tbody>
</table>

1. $0.00
2. $0.00
3. $0.00
4. $0.00
5. $0.00

GRAND TOTAL CHANGE ORDER AMOUNT:  $0.00
CITY OF PHOENIX: Water Services Department  
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation Engineering Design Services  
PROJECT NUMBER: WS85050051

---

Form 01330-J

CHANGE ORDER

CITY OF PHOENIX  
WATER SERVICES DEPARTMENT  
CONSTRUCTION MANAGEMENT DIVISION

<table>
<thead>
<tr>
<th>CONTRACT CHANGE ORDER NO. X</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>PROJECT NUMBER</th>
<th>PROJECT TITLE</th>
<th>NAME OF PROJECT</th>
</tr>
</thead>
</table>
| WSXXXXXXXX-1   | NAME OF CONTRACTOR | % COMPLETE($) | % TIME USED |%
| XX            | NAME OF CONTRACTOR | XX% | XX% |

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:**

**Work Change Directive No:**

**Prepared BY:**

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

**Accepted (Contractor):**

**Company/Firm:**

**Name of Contractor:**

**Signature:**

**Title:**

**Prepared By:**

---

**Recommended By:**

**Recommended By:**

**Recommended By:**

**Recommended By:**

**Recommended By:**

**Approved By:**

**Approved By:**

**Approved By:**

**Approved By:**

---

01330-J  
NOVEMBER 2016
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

---

**Form 01330-K**
REQUEST FOR INFORMATION

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<tr>
<th>CONTRACTOR</th>
<th>RFI#</th>
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</thead>
<tbody>
<tr>
<td>Requested By</td>
<td>Directed to</td>
</tr>
<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 __________________

---

REPLY:

Date __________________ Signature __________________
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

Form 01330-L
REQUEST FOR ALTERATION

CONTRACTOR__________________________ RFA# _______________________
Requested By__________________________ Directed to ___________________
Subject______________________________ Date Received __________________
Spec. Section________________________ Date Transmitted ________________
Drawing References____________________ Date Reply Received ____________
Date Reply Needed_____________________ Date Reply Transmitted __________

REQUESTED ALTERATION:

Date ___________________ Signature _______________________

REPLY:

Date ___________________ Signature _______________________

01330-L NOVEMBER 2016
Form 01330-M

CONTRACTOR’S DAILY CONSTRUCTION REPORT

CONTRACTOR

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

<table>
<thead>
<tr>
<th>CONTRACTORS WORK FORCE:</th>
<th>SUBCONTRACTORS WORK FORCE:</th>
<th>EQUIPMENT ON SITE:</th>
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<tbody>
<tr>
<td>Administrative</td>
<td>Mechanical</td>
<td>Cranes</td>
</tr>
<tr>
<td>Supervisors</td>
<td>Electrical</td>
<td>Loaders</td>
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<tr>
<td>Carpenters</td>
<td>Instrumentation</td>
<td>Dozers</td>
</tr>
<tr>
<td>Iron Workers</td>
<td>Site work</td>
<td>Scrapers</td>
</tr>
<tr>
<td>Operators</td>
<td>Masonry</td>
<td>Compactors</td>
</tr>
<tr>
<td>Finishers</td>
<td>Roofing</td>
<td>Compressors</td>
</tr>
<tr>
<td>Welders</td>
<td>Rebar</td>
<td>Welders</td>
</tr>
<tr>
<td>Electricians</td>
<td>Foundation</td>
<td>Graders</td>
</tr>
<tr>
<td>Laborers</td>
<td>Painting</td>
<td>Trucks</td>
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<tr>
<td></td>
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<td>Backhoe</td>
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</tbody>
</table>

Work Performed:

Material and Equipment Delivered:

Remarks:

By: ____________________

Title: ____________________

01330-M     NOVEMBER 2016
Form 01330-O

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.

Project Name: _______________  Submittal Description: _______________
Project No.: _______________  Submittal No.: _______________
Project Location: _______________  Specifications: _______________
Contractor’s Name: _______________  Section: _______________
                                        Page No.: _______________
Received By: _______________  Para. No.: _______________
Date: _______________  Drawing No.: _______________ of _______________

Review Checklist

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

No. Deviation

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>
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</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>
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<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
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>

Total Deduction from Contractor Contingency $0.00

ADJUSTMENTS:
- This Contingency Amount $0.00
- Prior Contingency Amount $0.00
- Original Contingency Amount $0.00
- Adjusted Contractors Contingency $0.00

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

RECOMMENDED BY:  __________________________________ DATE: _________  
CONTRACTOR

REVIEWED BY:  __________________________________ DATE: _________  
ENGINEER

AKNOWLEDGED:  __________________________________ DATE: _________  
OWNER
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

Form 01332-A

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>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>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Engineer</td>
<td></td>
<td></td>
<td></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
**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>Yes</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Equipment Manufacturer Catalog Datasheets Provided per piece of Equipment</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Suggested Spare Parts List Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Equipment Drawings Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Equipment and System Wiring Diagrams Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Applicable Certificates are Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Mounting Templates, Instructions and Design Calculations were Provided as Required</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>Required Maintenance Operations for Equipment 24 month Idle Period Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>Unloading and Handling Methods Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>Storage Requirements Provided</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>Equipment Paint Submittal Provided and Meets Requirements of Division 9</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>12</td>
<td>Drawings of Equipment Dimensions Field Verifications</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>13</td>
<td>Materials that Contact Drinking Water Comply with Specifications for Drinking Water</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>14</td>
<td>Submittal Includes requirements of Specification 01821 Instruction of Operations and Maintenance Personnel</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>15</td>
<td>Equipment Specification Requirements have been meet</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**CONTRACTOR’S SIGNATURE/DATE:_________________________**  
**ENGINEER’S SIGNATURE/DATE:_________________________**  

[Signature]

01332-B NOVEMBER 2016
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**

<table>
<thead>
<tr>
<th>Mechanical</th>
<th>Isolate, lockout and de-energize to zero potential energy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engulfment</td>
<td>Blank/block/cap/bleed off lines. Lock out gates, valves, pumps.</td>
</tr>
<tr>
<td>Electrical</td>
<td>Lockout/Tagout</td>
</tr>
<tr>
<td>Inerting</td>
<td>Flush/Purge/Vent</td>
</tr>
</tbody>
</table>

**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</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:

Entry Supervisor: Designated Attendant:
Authorized/Qualified Entrants:

Entry-Team Rotation:
Date: Time:

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: ____________________
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 SCHEMATICS).

**“CMMS TAG” # AND SERIALIZED 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.
Form 01600-A
(INsert Project Title)
EQUIPMENT INFORMATION FORM

Facility Location: ___________________________ Date: ___________________________

Service Desc: ___________________________ Process Location: ___________________________

Spec Section #: ___________________________ Drawing Ref: ___________________________

CMMS TAG #: ___________________________ Serialized Key #: ___________________________

Vendor: ___________________________ Assoc. Equipment: ___________________________

Manuf: ___________________________ Type: ___________________________

Model #: ___________________________ Size: ___________________________

Serial #: ___________________________ GPM: ___________________________

Temperature Range: ___________________________ PSI Range: ___________________________

CFM: ___________________________ Operating Range: ___________________________

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:
________________________________________
________________________________________

Mechanical Data:

Belt Manufacturer: ___________________________ Belt Model #: ________ Number of Belts: ________
Bearing Manufacturer: ___________________________ Bearing Model #: ___________________________
Weight Oil Used: ___________________________ Amount Oil Required: ___________________________

Miscellaneous Info:
________________________________________
________________________________________

________________________________________
________________________________________

01600-A NOVEMBER 2016
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: __________________________
# EQUIPMENT MANUFACTURER/VENDOR/INSTALLER INFORMATION FORM

**Project Title:**

**Equipment Type:**

## MANUFACTURER:
- **Name:** ____________________________
- **Address:** __________________________
- **City/State/Zip Code:** __________________
- **Office Phone:** _____________________
- **Fax:** _____________________________
- **Web site:** __________________________
- **E-mail address:** _____________________

## LOCAL REPRESENTATIVE:
- **Name:** ____________________________
- **Address:** __________________________
- **City, State, Zip:** ________________
- **Office Phone:** _____________________
- **Fax:** _____________________________
- **Web site:** __________________________
- **E-mail address:** _____________________

## INSTALLER:
- **Name:** ____________________________
- **Address:** __________________________
- **City, State, Zip:** ________________
- **Office Phone:** _____________________
- **Fax:** _____________________________
- **Web site:** __________________________
- **E-mail address:** _____________________
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

01620-A  NOVEMBER 2016
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

Form 01620-B
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: __________________
Sender: ___________________________ Manufacturer: ______________________
________________________________________
Received By: ______________________ Date: ______________________
P.O. No.: ___________________________ USPS Tracking No. ______________________
Storage Facility Location: ______________________

<table>
<thead>
<tr>
<th>Item</th>
<th>Review Description</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
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<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>
<td>☐</td>
<td>☐</td>
</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 __________________________________________________________________________

06120-B NOVEMBER 2016
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: ____________________________

CONTRACTOR | ENGINEER
Verified | Date | Verified | Date

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)

### Circuits:
- Power to MCC
- Control to HOA

### Indicators:
- Red (Running)
- Green (Stop)
- Other

### Misc. Local Control Panel:
- Wiring Labels Complete
- Nameplates
- Other
- Equipment Bumped for Rotation

## Piping Systems

### Cleaned and Flushed:
- Suction
- Discharge
- Pressure Tests
- Temporary Piping Screens in Place

## Instrumentation and Controls

### List Instruments:
- Instrument:___________

<table>
<thead>
<tr>
<th>CONTRACTOR Verified Date</th>
<th>ENGINEER Verified Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</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 __________________________
## OPERATIONS & MAINTENANCE MANUAL 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>Final copies required hard/soft</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>O&amp;M data review checklist Form 01781-B complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Copy of Applicable Specification Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Operating Instructions for each Piece of Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Spare Parts and Supply List</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Safety Precautions and MSDS of liquids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Equipment Manufacturer/Vendor/Installer Form</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Warranty Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>As built Control Panel and Wiring Diagrams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Final Test Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Disassembly/Reassembly, Alignment, Adjustment Checking Instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Installation Data and Instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Written Reference to CMMS Tag Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Equipment Information Form</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONTRACTOR’S SIGNATURE/DATE: ______________________________ ENGINEER’S SIGNATURE/DATE: ______________________________
## OPERATIONS & MAINTENANCE DATA REVIEW CHECKLIST

<table>
<thead>
<tr>
<th>REQUIRED DATA</th>
<th>ITEM COMPLETE</th>
<th>ITEM INCOMPLETE</th>
<th>COMMENT NO.</th>
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<tbody>
<tr>
<td><strong>GENERAL FORMAT</strong></td>
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</tr>
<tr>
<td>Copies Required (Hard/Soft) with Proper Labeling</td>
<td>01781-1.1.D.2</td>
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<td>01781-1.1.D.3</td>
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<tr>
<td>Paper Quality</td>
<td>01781-1.1.D.4.a</td>
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</tr>
<tr>
<td>Typed/Printed Originals</td>
<td>01781-1.1.D.4.b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-Ring Binder/Triple Post</td>
<td>01781-1.1.D.4.c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Binder Identification</td>
<td>01781-1.1.D.4.c</td>
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**PREVENTIVE MAINTENANCE INSTRUCTIONS**

| Tasks Required | 01781-1.1.C.2.b.1 | | |
| Recommended Schedule | 01781-1.1.C.2.b.2 | | |
| Lubrication Charts | 01781-1.1.C.2.b.3 | | |
**CITY OF PHOENIX:** Water Services Department  
**PROJECT NAME:** Reservoir 1-ES2-3 Rehabilitation  
**PROJECT NUMBER:** WS85050051

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<tr>
<th>REQUIRED DATA</th>
<th>ITEM COMPLETE</th>
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<th>COMMENT NO.</th>
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<td>01781-1.1.C.2.b.7</td>
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**Comments:**

1. 

**Engineer**  
**Date**
01783-A
SPARE PARTS RECEIVER FORM

CONTRACTOR TO FILL OUT:

MANUFACTURER:__________________________________________

ITEM DESCRIPTION:________________________________________

COST: ___________________________ PART NUMBER:________

VENDOR/SUPPLIER NAME:____________________________________

ADDRESS:________________________________________________

TELEPHONE NUMBER:_______________________________________

FAX NUMBER:_____________________________________________

PART TO BE USED ON WHAT EQUIPMENT:______________________

EQUIPMENT NUMBER: _____________ SPECIFICATION SECTION:______

*****************************************************************

_____________________________ ____________________________
CONTRACTOR REP DATE CITY REP
DATE

_____________________________
ENGINEER REP DATE
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 ________________________________
Signature of Authorized Representative ________________________________

Date ________________________________
Signature of OWNER’S Representative ________________________________

Date ________________________________
Signature of CONTRACTOR’S Representative ________________________________

01821-A NOVEMBER 2016
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): _______________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

01821-B NOVEMBER 2016
**REQUEST FOR BACTERIOLOGICAL SAMPLES**

**From:** TYPE NAME HERE  
**Fax:** XXX XXX-XXXX, **Telephone No.:** XXX XXX-XXXX  
**To:** Water Services Department  
Pollution Control Division - Fax: 602 534-7151

<table>
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<tr>
<th>Area/Zone #</th>
<th>Permit/Project #</th>
<th>Date Wanted:</th>
<th>Circle One: AM PM Any</th>
<th>Contractor:</th>
<th>Office On Site? Yes No Phone No.</th>
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</table>

**Location Of Risers:**

#1.  
#2.  
#3.  
#4.  
#5.  
#6.  

**Lines Represented:**

______________________

**Requested By Inspector:** ____________________  
**Beeper/Tel No.:** ____________________

**Test Results:**

- Pass  
  - Fax Date: ___________  
  - Time: ___________  
  - No. of Pages: ______

- Failed  
  - Faxed To: _______________  
  - Faxed By: _________________

- Bacteria  
- High Chlorine  
- No Pressure  
- No Risers  
- Other  

Inspectors Comments: ________________________________
## Form 16000-A

**WIRE AND CABLE RESISTANCE TEST DATA FORM**

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<th>Circuit Number/Feeder No.</th>
<th>Volts/Phase/Cycles</th>
<th>Phase “A” to Phase “B”</th>
<th>Phase “A” to Phase “C”</th>
<th>Phase “B” to Phase “C”</th>
<th>Phase “A” to Neutral</th>
<th>Phase “B” to Neutral</th>
<th>Phase “C” to Neutral</th>
<th>Phase “A” to Ground Conductor</th>
<th>Phase “B” to Ground Conductor</th>
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CERTIFIED ___________________________  Date________________________

CONTRACTOR’S Representative

WITNESSED ___________________________  Date________________________

OWNER’S Representative

16000-A  NOVEMBER 2016
Form 16000-G

PROTECTIVE RELAY TEST FORM

Location ____________________________________________

Switchgear Breaker No. ______________________________________

Protective Relay Description ______________________________________

A. The protective relays shall be tested in the following manner:

1. Each protective relay circuit shall have its insulation resistance tested to ground.

2. Perform the following tests on the specified relay setting:
   a. Pickup parameters on each operating element.
   b. Timing test shall be performed at three points on the time dial curve.
   c. Pickup target and seal-in units.

B. The results shall be recorded and signed by CONTRACTOR. A copy shall be provided to the ENGINEER in accordance with Section 01752, Equipment and System Startup and Performance Testing.

CERTIFIED ____________________________________________ Date_______________
CONTRACTOR’S Representative

WITNESSED ____________________________________________ Date_______________
OWNER’S Representative
Form 16000-H

LOW VOLTAGE SWITCHGEAR TEST FORM

Equipment No. ____________________________________________

Location ________________________________________________

Room Temperature _________________________________________

A. The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)

   Phase: A____  B____  C____
   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

   Phase          A  B  C
   Pole to ground ___ ___ ___ megohms
   Across open pole ___ ___ ___ megohms
   Pole to pole   AB  BC  CA ___ megohms

3. Minimum pickup current shall be determined by primary current injection.

4. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.

5. Short time pickup and time delay shall be determined by primary injection of current.

6. Instantaneous pickup current shall be determined by primary injection.

7. Trip unit reset characteristics shall be verified.

8. Auxiliary protective devices, such as ground fault or under voltage relays, shall be activated to ensure operation of shunt trip devices.

CERTIFIED ___________________________  Date____________________
CONTRACTOR’S Representative

WITNESSED ___________________________  Date____________________
OWNER’S Representative
MEDIUM VOLTAGE LOAD INTERRUPTER SWITCH TEST FORM

Equipment Number _________________________________________________________

Location _________________________________________________________________

Date _____________________________________________________________________

1. Measure switch blade resistance (micro-ohms).
   Phase: A_____ B_____ C_____  

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).
   Phase                  A     B      C
   Pole to ground  ____  ____  ____ megohms
   Across open pole  ____  ____  ____ megohms
   Pole to pole  AB  ____  BC  ____  CA  ____ megohms

The results shall be recorded and signed. A copy shall be provided to the ENGINEER in accordance with Section 01752, Equipment and System Startup and Performance Testing.

CERTIFIED ___________________________________________ Date________________
CONTRACTOR’S Representative

WITNESSED ___________________________________________ Date________________
OWNER’S Representative
Form 16000-J

LIQUID-FILLED TRANSFORMER TEST FORM

Equipment Number
Location
Date/Weather Conditions

A. Perform the “Insulation-Resistance Test” and “Dielectric Absorption Test” using Form 16000-C, Dry Transformer Test Data Form.

B. Perform an applied voltage (low frequency dielectric) test in accordance with ANSI C57.12.90, Paragraph 10.5, and Applied Voltage Test. Applied voltage levels shall be 75 percent of recommended factory test levels or recommended test levels of ANSI C57.12.00, Table 5.

C. Insulating oil shall be sampled and shall be laboratory tested for the following:
   1. Dielectric strength.
   2. Acid neutralization.
   3. Interfacial tension.
   5. Power factor.

D. Perform a turn’s ratio test between the windings for all tap positions.

E. The temperature and pressure switches shall be tested using a hot oil bath and air pump.

F. The results shall be recorded and signed by CONTRACTOR and ENGINEER. A copy shall be provided to the ENGINEER in accordance with Section 01752, Equipment and System Startup and Performance Testing. Any readings which are abnormal to ANSI industry standards shall be reported to the ENGINEER.

CERTIFIED ___________________________ Date____________________
CONTRACTOR’S Representative

WITNESSED ___________________________ Date____________________
OWNER’S Representative
Form 16000-K

AUTOMATIC TRANSFER SWITCH TEST FORM

Equipment Number ____________________________________________
Location ______________________________________________________
Date ____________________________________________________________________________________

1. Perform an insulation resistance test (1000 volts DC for 1 minute):

   Phase
   
   A   B   C
   Pole to ground   ___ ___ ___ megohms
   Pole to pole    AB ___ BC ___ CA ___ megohms

2. Perform the following operations and initial:

   a. Manual transfer ________________

   b. Loss of normal power; ___ sec delay

   c. Return to normal power; ___ sec delay

The results shall be recorded and signed. A copy shall be provided to the ENGINEER in accordance with Section 01752, Equipment and System Startup and Performance Testing.

CERTIFIED ___________________________ Date____________________
CONTRACTOR’S Representative

WITNESSED ___________________________ Date____________________
OWNER’S Representative
Form 16000-L

NEUTRAL GROUNDING RESISTOR TEST

Equipment No.: ____________________________________________
Location: __________________________________________________
Date: ____________________________

A. The pickup and time delay setting on the ground fault relay shall be set in accordance with Section 16061, Grounding Systems.

1. The transformer neutral insulation resistance shall be measured with and without the grounding resistor connected to insure no parallel ground paths exist.

2. The protective relay pickup current shall be determined by injecting test current into the current sensor. The pickup current should be within ten percent of the dial setting. Record the dial setting and actual pickup tie.

3. The relay timing shall be tested by injecting 150 and 300 percent of pickup current into the current sensor. The relay timing shall be in accordance with the manufacturer’s published time-current characteristic curves. Record the relay timing at 150 and 300 percent of pickup current.

4. The circuit interrupting device shall be operated by operating the relay.

B. The results shall be recorded and signed by the CONTRACTOR and ENGINEER. A copy shall be provided to the ENGINEER in accordance with Section 01752, Equipment and System Startup and Performance Testing.

CERTIFIED _____________________________ Date________________________
CONTRACTOR’S Representative

WITNESSED _____________________________ Date________________________
OWNER’S Representative
CONDUIT AND WIRE TERMINATION SHEET

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<th>From</th>
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<th>Via</th>
<th>To</th>
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<th>Service Description</th>
<th>DWG No.(s)</th>
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CONDUIT NO.: ____________  No. of Wires: ____________  Size: ____________
Process Area: _______________________

Form 16000-M
## GROUND TEST POINT DATA FORM

### COMPANY NAME

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<th>STREET ADDRESS</th>
<th>CITY, STATE ZIP</th>
<th>TELEPHONE</th>
<th>FAX</th>
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### PROJECT INFORMATION

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<th>Study Firm Representative:</th>
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<td>Contract Drawing #:</td>
<td>Contract Reference Spec. #</td>
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<th>Location in Building:</th>
<th>Equipment Name:</th>
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<th>Bus Type:</th>
<th>Voltage:</th>
<th>Amperage:</th>
<th>Conductor Termination</th>
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### ATMOSPHERIC CONDITIONS

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<th>Soil Conditions:</th>
<th>Date Since Last Measureable Rain:</th>
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### BONDING TYPE (check applicable)

- Concrete Incased UFeR [ ]
- Ground Grid [ ]
- Building Steel [ ]
- ¾ x 10’ Copper Ground Rod [ ]
- Cold Water Pipe [ ]
- Chemical Ground Rod [ ]
- Gas Pipe [ ]
- Other: [ ] (Explain): [ ]

### TEST RESULTS

<table>
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<tr>
<th>OHMS:</th>
<th>Notes:</th>
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### WITNESSED

**ENGINEER**

Date

**OWNER’S Representative**

Date

---

16000-N November 2016
FORM 16215-A

POWER COORDINATION/ARC FLASH LABELING FORM

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

<table>
<thead>
<tr>
<th>Project Title:</th>
<th>Study Firm Representative:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plant/Site:</th>
<th>City of Phoenix Project #: WS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contract Drawing #:</th>
<th>Contract Reference Spec. #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Per Specification 16215 – Power Study, the Power Coordination - Arc Flash Analysis Report breaker settings, arc flash labels, single line diagrams, load summaries, lighting and power 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.

__________________________________________

ENGINEER’S Representative (Print Name & Sign)
### Table 2: Recommended Low Voltage Breaker Settings

<table>
<thead>
<tr>
<th>Reference 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></td>
<td></td>
<td></td>
<td>R/S</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LTPU</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>LTD</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>STPU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STD</td>
</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
<td>INST</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td>GNDPU</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>GNDD</td>
</tr>
</tbody>
</table>

- EXISTING
- REC

Note: The table continues with similar entries for each referenced breaker and sensor pair.
## ADD GENERATOR TO FLEET – INSPECTION CHECKLIST

### Site Information:

<table>
<thead>
<tr>
<th>Site Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>Access Requirements and Restrictions:</td>
<td></td>
</tr>
</tbody>
</table>

### Supplier Information:

<table>
<thead>
<tr>
<th>Company Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>Phone #:</td>
<td></td>
</tr>
<tr>
<td>Start-Up Date:</td>
<td></td>
</tr>
<tr>
<td>Cost:</td>
<td></td>
</tr>
<tr>
<td>PO#</td>
<td></td>
</tr>
</tbody>
</table>

### General Information:

<table>
<thead>
<tr>
<th>GENERATOR</th>
<th>Year:</th>
<th>Make:</th>
<th>Model:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial #:</td>
<td>Spec:</td>
<td>Hrs:</td>
<td></td>
</tr>
<tr>
<td>KW</td>
<td>Voltage:</td>
<td>Phase:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARRANTY</th>
<th>Yrs:</th>
<th>Hrs:</th>
<th>Start Date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>BREAKER AMPS</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ENGINE</th>
<th>Mfg:</th>
<th>Model:</th>
<th>Serial #:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FUEL</th>
<th>Type:</th>
<th>Capacity:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ALTERNATOR</th>
<th>Mfg:</th>
<th>Model:</th>
<th>Serial #</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>BATTERIES</th>
<th>Mfg:</th>
<th>Group Size:</th>
<th>Quantity:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>BELTS</th>
<th>Fan:</th>
<th>Alternator:</th>
<th>Other:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FILTERS</th>
<th>Oil:</th>
<th>Air:</th>
<th>Fuel:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>HOSES:</th>
<th>Upper:</th>
<th>Lower:</th>
<th>Bypass:</th>
</tr>
</thead>
</table>
Form 17001-A

INSTRUMENT TUBING LEAK TEST FORM

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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</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>
</tr>
</thead>
<tbody>
<tr>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>□ Increasing □ Decreasing</td>
</tr>
<tr>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>□ Increasing □ Decreasing</td>
</tr>
<tr>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>□ Increasing □ Decreasing</td>
</tr>
<tr>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>_____</td>
<td>□ Increasing □ Decreasing</td>
</tr>
</tbody>
</table>

Instrument Programming Parameters

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Parameter No.</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>_____</td>
<td>_____</td>
</tr>
<tr>
<td>2.</td>
<td>_____</td>
<td>_____</td>
</tr>
<tr>
<td>3.</td>
<td>_____</td>
<td>_____</td>
</tr>
<tr>
<td>4.</td>
<td>_____</td>
<td>_____</td>
</tr>
</tbody>
</table>

CERTIFIED ___________________________ Date________________________

CONTRACTOR’S Representative

WITNESSED ___________________________ Date________________________

OWNER’S Representative
**CITY OF PHOENIX:** Water Services Department  
**PROJECT NAME:** Reservoir 1-ES2-3 Rehabilitation  
**PROJECT NUMBER:** WS85050051

---

**Form 17001-C**

**FUNCTIONAL ACCEPTANCE TEST**

<table>
<thead>
<tr>
<th>System:</th>
<th>P&amp;ID No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop No.:</td>
<td>Page of</td>
</tr>
</tbody>
</table>

**Factory Acceptance Test:**

<table>
<thead>
<tr>
<th>Tag Number:</th>
<th>Loop Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument Location:</td>
<td>Manufacturer:</td>
</tr>
<tr>
<td>Model Number/Serial Number:</td>
<td>Adjustable Range:</td>
</tr>
<tr>
<td>Calibrated Range:</td>
<td>Remarks:</td>
</tr>
</tbody>
</table>

**Installation Per Manufacturer’s Requirements?**  
**Installation Per Contract Documents?**  
If “No,” Explain:

<table>
<thead>
<tr>
<th>Calibration Test:</th>
<th>Switch Test:</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>Calibration Signal</td>
</tr>
<tr>
<td>---</td>
<td>-----------------</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
CITY OF PHOENIX: Water Services Department  
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation  
PROJECT NUMBER: WS85050051  

Form 17260-A  

FACTORY ACCEPTANCE TEST REPORT  

**PROJECT TITLE**  

Witnessing Firm(s):  
Testing Date:  
Witnessed by:  

Equipment Name:  
Manufacturer:  
Location of Test:  

**REVIEW CHECKLIST**  

<table>
<thead>
<tr>
<th>REVIEW ITEMS</th>
<th>ITEM COMPLETE</th>
<th>ITEM INCOMPLETE</th>
<th>COMMENT NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRIOR TO FACTORY ACCEPTANCE TEST</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Panels Shall Be Furnished In Accordance With The Requirements As Shown On The Drawings And As Specified In Specification 16050, 17051, 17052, 17053, 17226 and 17260.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was The System Internally Tested By Manufacturer.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approved Submittal Available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Construction Fully Completed And Panel Clean Of Debris</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming Of All Devices And Logic Controllers Completed, Installed And Printed Program Copies Available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Drawings As-Built And Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations &amp; Maintenance Manual Completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MECHANICAL INSPECTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturers UL 508 Label Installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosure is NEMA Rated Per Specification 16050</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosure Door Seals, Gaskets, Alignment, Latches And Locking Mechanisms Installed And Functioning Properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Painted Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REVIEW ITEMS</td>
<td>ITEM COMPLETE</td>
<td>ITEM INCOMPLETE</td>
<td>COMMENT NO.</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Front Panel Nameplates And Components Installed Per Specifications And NEMA Rated For Application</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arc Flash Labels Installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Components Mounted Securely And Locations Are As Per Approved Submittal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component Fasteners Constructed Of Stainless Steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panels And Shelves Constructed Of Minimum 12 Gage Steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wireways Covered And Wire Fill Limits Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Wires Are Terminated And Labeled Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare Free Space Capacity Percentage Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduit Entry Points Free Space Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel Print Pocket With White Enamel Finish Provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosure Mounting And Lifting Supports Provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Conditioner and Drain Line Installed and Functioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunshade Structure Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipping Container and Preparations Reviewed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PANEL COMPONENTS**

<table>
<thead>
<tr>
<th>REVIEW ITEMS</th>
<th>ITEM COMPLETE</th>
<th>ITEM INCOMPLETE</th>
<th>COMMENT NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components Are Per Bill Of Materials And Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components Are UL Listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Fixture And Operation Switch Installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grounding Studs And Bars For The Door, Backplane And Controls Installed For AC And DC Circuits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Conditioner, Heat Exchanger, Ventilation Fan Or Heater Installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermostat And Panel High Temperature Switch Installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Internal Components Labeled Per Specification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuses Labeled on the Backplane with Fuse Number and Fuse Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REVIEW ITEMS</td>
<td>ITEM COMPLETE</td>
<td>ITEM INCOMPLETE</td>
<td>COMMENT NO.</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Wire Type, Colors, Size, Labeling, Routing And Terminations Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Front Nameplate #1 As Per Specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Incoming Power Terminated To PTB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare Parts Provided</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PANEL TESTING**

<table>
<thead>
<tr>
<th>PANEL TESTING</th>
<th>ITEM COMPLETE</th>
<th>ITEM INCOMPLETE</th>
<th>COMMENT NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>List Test Equipment Used For The Factory Acceptance Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List All Personal Protective Equipment Utilized For Factory Acceptance Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify Panel Is Grounded and Test All Panel Grounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify All Circuit Breaker And Fuse Sizes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify Safety Circuits Are Fail Safe Including From The Panel To the Field Device</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power On Verification Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure Panel Power Consumption – Test Total System Current With System In Non-Loaded State</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Measured: ________________</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit Breaker And Disconnect Switch - Power On/Off/Lock-out Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test All Power Supply(s) Voltages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Measured: ________________</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test All Panel Start/Stop Controls And Computer Generated Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Emergency Stop Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify All Starters, Relays And Contactors Activate As Required</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulate All I/O As Near As Possible To The Installed System Configuration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulate All Analog Signals Including Field Devices Inputs and Computer Control Inputs By Varying The Analog Inputs Between 4 – 20 mA's DC - 0 To 100% Ranges.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify All Calibrations And Set Points Of Panel Components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REVIEW ITEMS</td>
<td>ITEM COMPLETE</td>
<td>ITEM INCOMPLETE</td>
<td>COMMENT NO.</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Test All Programmable Logic Controller Serial Ports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Programmable Logic Controller Retentative Memory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Programmable Logic Controller Power Failure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test All Start Up And Shut Down Sequence Procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test All Alarms</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:
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, 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. Applicable certifications.
   5. Required maintenance operations to allow all installed equipment to remain idle for a period of time not to exceed 24 months.
   6. Other technical, installation, and maintenance data as applicable.
   7. Unloading and handling methods and storage requirements.
   8. Note, highlight, and explain proposed changes to the Contract Documents.
   9. 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.
   10. 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.
   11. For materials or products which can contact drinking water should be in compliance with NSF/ANSI61 Standards.
C. Preliminary Submittal Schedule: CONTRACTOR, within 7 days after the Notice to Proceed, shall prepare and submit to the ENGINEER a Preliminary Submittal Schedule. Identify on his Preliminary Submittal Schedule all of the submittal items required by the Contract Documents governing the Work.

D. Submittal Schedule: CONTRACTOR, within 14 days after the Notice to Proceed, shall prepare and submit to the ENGINEER a comprehensive Submittal Schedule. Identify on his Submittal Schedule all of the submittal items required by the Contract Documents governing his Work. Indicate, for each submittal item on his Submittal Schedule the following:

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

E. In preparing his Submittal Schedule, 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. 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.
G. CONTRACTOR’S Submittal Schedule shall be consistent with the Progress Schedule as described in Section 01320, Progress Schedule.

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

1.2 PROCEDURE

A. Submit Shop Drawings to: To be defined at Pre-construction Conference.

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: City of Phoenix Water Services Department
   2. Project Name: Reservoir 1-ES2-3 Rehabilitation Engineering Design Services
   3. Contract No.: WS85050051
   4. Transmittal No.: __________________________
   5. Section No.: __________________________

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

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

G. All Shop Drawings submitted shall bear the stamp of approval and signature of CONTRACTOR as evidence that they have been reviewed and verified to the completeness of the submittal by CONTRACTOR. Submittal without this stamp of approval will not be reviewed by ENGINEER and will be returned to CONTRACTOR. CONTRACTOR’S stamp contain the following minimum information:
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>
</tr>
</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 eight (8) HARD copies and (--)1--) 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 copy and 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 print or copy and electronic PDF format 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, five (5) 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 ++
PART 1 - GENERAL

1.1 DESCRIPTION

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

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

1.2 PROCEDURE

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

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

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

1.3 SAMPLES FOR TESTS

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

PART 2 - PRODUCTS (NOT USED)
PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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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. 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.
   3. A manual has been prepared by the Maricopa County Flood Control District to aid in CONTRACTOR’S preparation of the SWPPP. This manual, "Drainage Design Manual for Maricopa County Arizona, Volume III, Erosion Control" is available at the Flood Control District Office, 2801 West Durango Street, Phoenix, Arizona. The complete Construction General Permit is in the December 8, 1999, Federal Register available at local libraries and is also available from the ADEQ website at www.adeq.state.az.us/environ/water/permits/download/constgp.pdf.

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)  
++ END OF SECTION ++
SECTION 01414

EARTHMOVING AND DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

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

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

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

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

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)
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 ++

01415-2 NOVEMBER 2016
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.
8. Polyvinyl chloride liner.

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 +++
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:

<table>
<thead>
<tr>
<th>Term</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>alternating current</td>
<td>AC</td>
</tr>
<tr>
<td>Ampere</td>
<td>A</td>
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<tr>
<td>ante meridiem</td>
<td>am</td>
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<tr>
<td>Average</td>
<td>avg.</td>
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<tr>
<td>biochemical oxygen demand</td>
<td>BOD</td>
</tr>
<tr>
<td>brake horsepower</td>
<td>BHP</td>
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<tr>
<td>British thermal unit</td>
<td>BTU</td>
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<tr>
<td>Centigrade</td>
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<td>Company</td>
<td>Co.</td>
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<td>cubic inch</td>
<td>cu. in.</td>
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<td>cubic foot</td>
<td>cu. ft.</td>
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<tr>
<td>cubic yard</td>
<td>cu. yd.</td>
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<tr>
<td>cubic feet per minute</td>
<td>cfm</td>
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<tr>
<td>cubic feet per second</td>
<td>cfs</td>
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<tr>
<td>Decibel</td>
<td>DB</td>
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<td>degree Centigrade (or Celsius)</td>
<td>(Say) 20°C</td>
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<tr>
<td>degree Fahrenheit</td>
<td>(Say) 68°F</td>
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<td>Diameter</td>
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<td>Term</td>
<td>Abbreviation</td>
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<td>inch</td>
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</tr>
<tr>
<td>inch-pound</td>
<td>in.-lb</td>
</tr>
<tr>
<td>inside diameter</td>
<td>id</td>
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<tr>
<td>kilovolt-ampere</td>
<td>kva</td>
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<tr>
<td>kilowatt</td>
<td>KW</td>
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<tr>
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<tr>
<td>linear foot</td>
<td>lin. ft.</td>
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<td>liter</td>
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<tr>
<td>Term</td>
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<td>maximum</td>
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<td>mercury</td>
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<td>million gallons per day</td>
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<tr>
<td>minimum</td>
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<td>National Pipe Threads</td>
<td>NPT</td>
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<tr>
<td>net positive suction head</td>
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<td>number</td>
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<td>parts per million</td>
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<td>post meridiem</td>
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<tr>
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<td>pounds per square inch absolute</td>
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<tr>
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<tr>
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<td>square yard</td>
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</tbody>
</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).
13. Concrete Reinforcing Steel Institute (CRSI).
15. Institute of Electrical and Electronics Engineers (IEEE).
16. National Electrical Manufacturer’s Association (NEMA).
19. Occupational Safety and Health Administration (OSHA).
21. Prestressed Concrete Institute (PCI).
22. Underwriters’ Laboratories, Inc. (UL).
23. All other applicable standards listed in the Specifications and the standards of utility service companies, where applicable.
24. 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.

32. International Mechanical Code, with City of Phoenix Amendments.
33. Uniform Plumbing Code, with City of Phoenix Amendments.
34. 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.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix Building Code</td>
<td>International Building Code with City of Phoenix Amendments</td>
</tr>
<tr>
<td>Phoenix Electrical Code</td>
<td>National Electric Code – NFPA 70 with City of Phoenix Amendments</td>
</tr>
<tr>
<td>Phoenix Fuel and Gas Code</td>
<td>International Fuel and Gas Code with City of Phoenix Amendments</td>
</tr>
<tr>
<td>Phoenix Mechanical Code</td>
<td>International Mechanical Code with City of Phoenix Amendments</td>
</tr>
<tr>
<td>Phoenix Plumbing Code</td>
<td>Uniform Plumbing Code with City of Phoenix Amendments</td>
</tr>
</tbody>
</table>
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 Reference Specifications specified in this document from Division 2 through Division 16.

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

1.5 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

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

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

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

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

1. AA    Aluminium Association
2. AABC  Associated Air Balance Council
3. AAMA  American Architectural Manufacturers Association
4. AASHTO American Association of State Highway and Transportation Officials
| 5. | ACI | American Concrete Institute |
| 6. | ACS | American Chemical Society |
| 7. | AFBMA | Anti-Friction Bearing Manufacturers’ Association |
| 8. | AGMA | American Gear Manufacturers Association |
| 9. | AI | Asphalt Institute |
| 10. | AIChE | American Institute of Chemical Engineers |
| 11. | AISC | American Institute of Steel Construction |
| 12. | AISI | American Iron and Steel Institute |
| 13. | AITC | American Institute of Timber Construction |
| 14. | ALS | American Lumber Standards |
| 15. | AMA | Acoustical Materials Association |
| 16. | AMCA | Air Movement and Control Association |
| 17. | ANSI | American National Standards Institute |
| 18. | APA | American Plywood Association |
| 19. | API | American Petroleum Institute |
| 20. | APHA | American Public Health Association |
| 21. | AREA | American Railway Engineering Association |
| 22. | ARI | Air Conditioning and Refrigeration Institute |
| 23. | ASA | American Standards Association |
| 24. | ASAE | American Society of Agricultural Engineers |
| 25. | ASTM | American Society for Testing and Materials |
| 26. | ASCE | American Society of Civil Engineers |
| 27. | ASHRAE | American Society of Heating, Refrigerating and Air Conditioning |
| 28. | ASME | American Society of Mechanical Engineers |
| 29. | AWI | Architectural Woodwork Institute |
| 30. | AWPA | American Wood Preservers’ Association |
| 31. | AWPB | American Wood Preservers Bureau |
| 32. | AWPI | American Wood Preservers’ Institute |
33. AWS American Welding Society
34. AWWA American Water Works Associations
35. BHMA Builders Hardware Manufacturers’ Association
36. CBMA Certified Ballast Manufacturers’ Association
37. CDA Copper Development Association
38. CGA Compressed Gas Association
39. CISPI Cast Iron Soil Pipe Institute
40. CMAA Crane Manufacturers’ Association of America
41. CRSI Concrete Reinforcing Steel Institute
42. EPA Environmental Protection Agency
43. ETL Engineering Test Laboratories
44. FCC Federal Communications Commission
45. FEMA Federal Emergency Management Agency
46. FGMA Flat Glass Marketing Association
47. FM Factory Mutual Association
48. FS Federal Specification
49. GA Gypsum Association
50. HEW Department of Health, Education and Welfare
51. HI Hydraulic Institute
52. HMI Hoist Manufacturers’ Institute
53. HUD Department of Housing and Urban Development
54. ICBO International Conference of Building Officials
55. ICEA Insulated Cable Engineers’ Association
56. IEEE Institute of Electrical and Electronic Engineers
57. IES Illuminating Engineering Society
58. IFI Industrial Fasteners Institute
59. IRI Industrial Risk Insurers
60. ISA The Instrumentation Systems and Automation Society
61. ISO  Insurance Services Office
62. MAG  Maricopa Association of Governments
63. MIA  Marble Institute of America
64. MS   Military Specifications
65. MMA  Monorail Manufacturers’ Association
66. NAAMM  National Association of Architectural Metal Manufacturers
67. NACE  National Association of Corrosion Engineers
68. NARUC  National Association of Railroad and Utilities Commissioners
69. NBHA  National Builders Hardware Association
70. NEC   National Electrical Code
71. NEMA  National Electrical Manufacturers Association
72. NESC  National Electrical Safety Code
73. NFPA  National Fire Protection Association
74. NHLA  National Hardwood Lumber Association
75. NHPMA  Northern Hardwood and Pine Manufacturer’s Association
76. NLMA  National Lumber Manufacturers’ Association
77. NRCA  National Roofing Contractors Association
78. NSF   National Sanitation Foundation
79. NTMA  National Terrazzo and Mosaic Association
80. NWWDA  National Wood Window and Door Association
81. OECI  Overhead Electrical Crane Institute
82. OSHA  Occupational Safety and Health Administration
83. PCI   Precast Concrete Institute
84. PEI   Porcelain Enamel Institute
85. PPI   Plastic Pipe Institute
86. PS    Product Standards Section-U.S. Department of Commerce
87. RMA   Rubber Manufacturers’ Association
88. SAE   Society of Automotive Engineers
89.  SCPRF  Structural Clay Products Research Foundation
90.  SDI  Steel Deck Institute
91.  SDI  Steel Door Institute
92.  SIGMA  Sealed Insulating Glass Manufacturing Association
93.  SJI  Steel Joist Institute
94.  SMACNA  Sheet Metal and Air Conditioning National Association
95.  SPI  Society of the Plastics Industry
96.  SSPC  The Society for Protective Coatings
97.  SWI  Steel Window Institute
98.  TEMA  Tubular Exchanger Manufacturers’ Association
99.  TCA  Tile Council of America
100.  UL  Underwriters’ Laboratories, Inc.
101.  USGS  United States Geological Survey
102.  USPHS  United States Public Health Service
103.  WCLIB  West Coast Lumber Inspection Bureau
104.  WWEMA  Water and Wastewater Equipment Manufacturers Association
105.  WWPA  Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +
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PART 1 - GENERAL

1.1 DESCRIPTION

A. The OWNER will, through the ENGINEER, employ and pay for an independent testing laboratory to perform the specified services.

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

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

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

1.2 QUALIFICATIONS OF LABORATORY

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

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

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1.3 LABORATORY DUTIES

A. The testing laboratory shall:
   1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
   2. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.
   3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies of Work that are observed during performance of services.
   4. Promptly submit five copies of reports of inspections and tests to ENGINEER, including:
      a. Date issued.
      b. Project title and number.
      c. Testing laboratory name and address.
      d. Date of inspection or sampling.
      e. Record of temperature and weather.
      f. Date of test.
      g. Identification of product and Specification Section.
      h. Location in Project.
      i. Type of inspection or test.
      j. Results of tests and observations regarding compliance with Contract Documents.
   5. Perform additional tests and services, as required by OWNER.

1.4 CONTRACTOR’S RESPONSIBILITIES

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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SECTION 01453

TESTING OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

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

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

<table>
<thead>
<tr>
<th>Hydraulic Structure Number</th>
<th>Hydraulic Structure Service and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reservoir 1-ES2-3</td>
<td>Roof Rehabilitation &amp; Liner Replacement. 24th Street Water Treatment Plant, Phoenix, Arizona.</td>
</tr>
</tbody>
</table>

C. Water for Testing:
   1. Water for initial testing will be furnished by the OWNER.
   2. Provide all temporary piping, pumps, hose, valves, backflow preventors, appurtenances, and services required for testing if the OWNER does not permit the use of the inlet pipe to fill the reservoir.
   3. Convey the water to the testing location.
   4. Water for testing may be withdrawn from:
      a. Coordinate with OWNER.
   5. The maximum rate at which water may be withdrawn is: Coordinate with OWNER. Provide on the withdrawal piping, downstream of the backflow preventor, a valve to control the rate of flow and a flow meter if the OWNER does not permit the use of the inlet/outlet pipe for this purpose. The flow meter shall be calibrated within one year and field calibrated/verified prior to the date of its use, and its certification of calibration shall be submitted to the ENGINEER for approval.
   6. Cost of water for re-testing shall be paid by CONTRACTOR to OWNER at OWNER’S standard rates.
1.2 DEFINITIONS

A. The term “hydraulic structures” is defined as tanks, channels, and other structures through which liquid is conveyed or that hold liquid. Hydraulic structures include structures that are open to the atmosphere and structures with closed tops. Hydraulic structures, include but are not limited to, wet wells, junction chambers, equalization tanks, storage tanks, and treatment process tanks such as grit chambers, clarifiers, aeration tanks, filter beds, contact tanks, and other channels or tanks as designated herein.

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

1.3 SUBMITTALS

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

B. Shop Drawings: Submit for approval the following:

1. Cleaning procedures.
2. Hydrostatic testing procedures, methods, equipment, coordination, and schedules.
3. Report for each test.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Temporary valves, bulkheads, and other water control equipment and materials, shall be determined by CONTRACTOR subject to the ENGINEER’S review. No materials shall be used which would be injurious to the construction or its future function. All equipment and materials should be NSF/ANSI 61 approved, shall comply with AAC R18-04-119 and shall impart no taste or odor to the water.

PART 3 – EXECUTION

3.1 CLEANING

A. Cleaning Requirements:

1. Remove all scaffolding, planks, tools, rags, dirt, debris, and material not part of the structure prior to testing.
1. Thoroughly clean the walls, floors, and operating equipment by sweeping, high-pressure wash, scrubbing, or other methods approved by ENGINEER.
2. Remove all water, dirt, or foreign material accumulated during cleaning from the hydraulic structure. Provide temporary pumps, piping, and facilities as required to discharge water from the cleaning operation in a manner approved by ENGINEER.
3. Do not proceed with testing until ENGINEER has approved the results of the cleaning operation.
4. Cleaning shall conform to the requirements of Section 01740, Cleaning.

3.2 GENERAL FOR TESTING AND DISINFECTION

A. The following requirements apply:
   1. Each hydraulic structure shall be tested for leakage and bacterial analysis.

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

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

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

3.3 HYDROSTATIC TESTING OF HYDRAULIC STRUCTURES

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

B. Prior to the start of hydrostatic testing, the following shall be met.
   1. All elements of the structure that will resist pressure exerted by the retained liquid shall be in place and at specified strength levels. Concrete shall be fully cured.
   2. Structure walls shall not be backfilled and, if damp proofing is specified, coated with damp proofing prior to leakage testing, unless otherwise approved by ENGINEER.
   3. All valves, gates, blind flanges, and other items, other than concrete, that control the flow of or otherwise retain the liquid contents of the structure, shall be checked for water-tightness. If not watertight, provide measures to ensure water-tightness during the hydrostatic test.
   4. Defective concrete shall be repaired.
   5. Notify ENGINEER and OWNER a minimum of 30 days prior to the start of filling of the structure for hydrostatic testing.
6. Concrete hydraulic structures shall remain filled with clean water for an initial 48-hour period to allow for adsorption. Following this initial period, add make-up water to fill the hydraulic structure to the specified water surface test elevation.

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

<table>
<thead>
<tr>
<th>Hydraulic Structure Number</th>
<th>Hydraulic Structure Service and Location</th>
<th>Water Surface Elevation for Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir 1-ES2-3</td>
<td>Roof Rehabilitation &amp; Liner Replacement, 24th Street Water Treatment Plant, Phoenix, Arizona.</td>
<td>El. 1282.55 (based on ADWR License to Operate)</td>
</tr>
</tbody>
</table>

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

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

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

G. Allowable Leakage:
1. Leakage is defined as the quantity of water that must be supplied to the hydraulic structure or any section thereof to maintain the water level within 3-inches of the specified water surface test elevation during the hydrostatic test, plus the amount of water required to fill the hydraulic structure to the specified water surface test elevation at the conclusion of the hydrostatic test, plus precipitation, minus an allowance for evaporation if applicable.
2. For concrete structures with interior wetted surfaces lined with a waterproof material, the allowable leakage is 0.1 percent of the volume tested per 72-hour period.

H. Measurement Locations:
1. Structures or structure cells that are less than 1,000 square feet in water surface area shall have measurements of water level taken at a minimum of two locations that are approximately 180 degrees apart.

2. Structures or structure cells that are greater than 1,000 square feet in water surface area shall have measurements of water level taken at a minimum of four locations that are approximately 90 degrees apart.

3. Each measurement location shall be marked and given a reference number. A reference point shall be marked on the face of the wall above the test water surface in a manner that will prevent movement or deterioration of the reference point mark during the test.

4. Measurement locations shall be located so that the effects of wave action and wind are minimized.

I. Evaporation and Precipitation Measurement:
1. In hydraulic structures that are open to the atmosphere, a clear plastic calibrated open-topped container not less than 18-inches in diameter and depth shall be partially filled, floated in the tank, and held in position near each measurement location. Calibration increments shall be 0.1-inch or less.

2. Containers shall be located so that they are not shaded by the structure’s walls, and are away from overhead items such as beams, pipes, and walkways.

J. Test Measurements:
1. Do not start hydrostatic tests when severe weather conditions, such as heavy precipitation, high winds, major changes in average daily temperature, and other severe conditions are predicted.

2. Record the following measurements at each test location at the start of the test period and at 12-hour intervals thereafter.
   a. Distance from reference point to test water surface.
   b. Depth of water in the evaporation-precipitation containers.
   c. Temperature of the test water at a point 18-inches below the water surface.
   d. Temperature of the water in the evaporation-precipitation containers at mid-depth.

3. If the water surface is subject to wave action at the measurement location, the average water surface elevation of the wave oscillations shall be recorded as the data.

4. The change in the water surface elevation at each measurement location shall be averaged and adjusted as follows:
   a. The total change in the hydraulic structure’s water surface elevation shall be adjusted by the average change in water surface elevation in the evaporation-precipitation containers.
   b. Where the averaged water temperature measurements vary by more than 3 degrees from start to completion of the test period, adjustment in the test volume shall be determined by the change of the density of
water resulting from the change in the average water temperature.

5. Determination of Leakage:
   a. Leakage shall be drop in water surface elevation measured during the test multiplied by the water surface area of the hydraulic structure.

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

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

++ END OF SECTION ++
SECTION 01454

DISINFECTION OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

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

B. Hydraulic Structures Scheduled for Disinfection:

<table>
<thead>
<tr>
<th>Hydraulic Structure Number</th>
<th>Hydraulic Structure Service and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reservoir 1-ES2-3</td>
<td>Roof Rehabilitation &amp; Liner Replacement. 24th Street Water Treatment Plant, Phoenix, Arizona.</td>
</tr>
</tbody>
</table>

C. Water for Disinfection:
1. Water for initial disinfecting will be furnished by the OWNER.
2. Provide all temporary piping, hose, valves, backflow preventors, appurtenances, and services required for disinfection if the OWNER does not permit the use of the inlet pipe to fill the reservoir.
3. Convey the water to the disinfection location.
4. Water for testing may be withdrawn from:
   a. Coordinate with OWNER.
5. The maximum rate at which water may be withdrawn is: Coordinate with OWNER. Provide on the withdrawal piping, downstream of the backflow preventor, a valve to control the rate of flow and a flow meter if the OWNER does not permit the use of the inlet/outlet pipe for this purpose. The flow meter shall be calibrated within one year and field calibrated/verified prior to the date of its use and its certification of calibration shall be submitted to the ENGINEER for approval. Disinfect the flow meter prior to use.
6. Cost of water for re-disinfecting and re-testing shall be paid by CONTRACTOR to OWNER at OWNER’S standard rates.
D. Chemicals for disinfection and dechlorination shall be provided by the CONTRACTOR.

1.2 REFERENCES

A. Comply with applicable provisions and recommendations of the following, unless otherwise shown or specified.
   1. ANSI/NSF 60, Drinking Water Treatment Chemicals – Health Effects.
   2. AWWA B100-80, Standard for Filtering Material (Preparation of Filter for Service).
   3. AWWA C652, Disinfection of Water-storage Facilities.
   4. AWWA C653, Disinfection of Water Treatment Plants.
   5. ACI 350-1R, Testing Reinforced Concrete Structures for Watertightness.
   8. AAC R18-4-119, Standards for Additives, Materials, and Equipment.

1.3 DEFINITIONS

A. The term “hydraulic structures” is defined as tanks, channels, and other structures through which liquid is conveyed or that hold liquid. Hydraulic structures includes structures that are open to the atmosphere and structures with closed tops. Hydraulic structures, include but are not limited to, wet wells, equalization tanks, storage tanks, treatment process tanks such as filter beds and other channels or tanks as designated herein.
   1. Excluded are structures where cleaning, testing, and disinfection are specified under other Sections.

1.4 QUALITY ASSURANCE

A. Testing Laboratory:
   1. Testing for bacteria and odor shall be performed by a laboratory certified by the regulatory authority having jurisdiction. Test results shall be submitted to ENGINEER.

1.5 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Disinfection procedures, methods, coordination, and schedules.
   2. Plan for disposal of chlorinated water, including proposed dechlorination chemical and methods.
   3. Certification of backflow preventors.
5. Data sheets on all chemicals used for disinfection and dechlorination.
6. NSF certifications for the chemicals used in disinfection and dechlorination.
7. NSF/ANSI 61 or AAC R18-04-119 certification for the equipment and materials.

B. Other Submittals: Provide the following:
1. Report for each test.
2. Chain of custody documentation for bacteriological and odor tests.
3. Certificates of compliance with referenced standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary valves, bulkheads, and other water control equipment and materials, shall be determined by CONTRACTOR subject to the ENGINEER'S review. No materials shall be used which would be injurious to the construction or its future function. All equipment and materials should be NSF/ANSI 61 approved, shall comply with AAC R18-04-119 and shall impart no taste or odor to the water.

B. Backflow preventors shall be tested by a certified backflow prevention technician and certified by the regulatory authority within one year or less of the backflow preventor’s use on this Project.

C. National Sanitation Foundation (NSF) Approvals: The following shall be NSF-approved:
1. Chemicals used for disinfection and dechlorination shall conform to ANSI/NSF 60.

PART 3 – EXECUTION

3.1 GENERAL FOR TESTING AND DISINFECTION

A. Disinfection shall be accomplished by chlorination. Chlorine dosages shall be as computed by the ENGINEER. Perform all testing, chlorination, and sampling operations in the presence of the ENGINEER.

B. Schedule disinfection operations as late as possible during the Contract Times, to provide the maximum degree of sterility at the time the Work is accepted by OWNER.
C. Bacteriological testing shall be performed by a certified testing laboratory provided by the OWNER. Results of the bacteriological testing shall be satisfactory to the regulatory authority.

D. Protective coatings for concrete shall be applied and cured before disinfection operations are initiated.

E. Release of water from structures, after disinfection shall be as approved by the OWNER and ENGINEER.

3.2 DISINFECTING HYDRAULIC STRUCTURES

A. Hydraulic structures that are specified as requiring disinfection shall be chlorinated by CONTRACTOR in accordance with AWWA C652, Chlorination Method 2, unless otherwise specified.

B. Contractor may submit a written request and plan to perform disinfection in accordance with AWWA C652, Chlorination Methods 1 or 3.

C. Disinfection:
   1. Provide temporary taps, plugs, valves, drains, pumps, tanks, piping, facilities, and connections required to disinfect, de-chlorinate, and remove the chlorinated water as specified.
   2. Perform disinfection of each hydraulic structure immediately before the structure is placed in operation to prevent the facility from becoming contaminated after being disinfected.
   3. Use a solution of water and liquid chlorine, calcium hypochlorite, or sodium hypochlorite. Placement of chlorine powder or tablets inside the hydraulic structure as a means of disinfection is not allowed.
   4. Introduce the chlorine solution into the structure in a manner approved by ENGINEER.
   5. Add potable water to the hydraulic structure with the chlorine solution. Water shall be introduced to the hydraulic structure through a reduced pressure zone-type backflow prevention device.
   6. Upon completion of each disinfection operation, dechlorinate the contents of the hydraulic structure until the chlorine residual equals the residual in the local potable water system. If the residual of the local potable water system is not available, dechlorinate to a maximum chlorine residual of 0.5 mg/L. Dechlorination shall be in accordance with AWWA C653.
   7. Discharge of chlorinated water into a sewer will not be allowed without written approval of the OWNER of the wastewater conveyance system and wastewater treatment facility. Chlorinated water shall not be discharged onto roadways or into ditches, storm sewers, culverts, streams, or wetlands.
D. After disinfection is completed and before the hydraulic structure is placed in service, the hydraulic structure shall be tested for odor and bacteria in accordance with the requirements of AWWA C652 and the latest edition of *Standard Methods for Examination of Water and Wastewater*.

E. Samples for bacteriological and odor testing shall be obtained from the hydraulic structure as follows:
   1. Immediately after completion of disinfection: A minimum of two samples.
   2. Twenty-four hours after obtaining first set of samples: A minimum of two samples.

F. Samples for bacteriological and odor tests will be taken by OWNER. Test results for the samples shall indicate satisfactory results for bacteria and odor, in accordance with regulatory authority requirements, before the hydraulic structure will be accepted.

G. Repeat the disinfection procedure at no additional cost to OWNER until the test results indicate satisfactory results for bacteria and odor.

++ END OF SECTION ++
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SECTION 01510

TEMPORARY CONSTRUCTION FACILITIES

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°F, unless otherwise specifically accepted in the Specifications.

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

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

G. Furnish and maintain a safe drinking water supply readily available to all workers.
H. Responsible for all utility service costs until Final Acceptance of the Work. Included are all fuel, power, light, heat and other utility services necessary for execution, completion, testing and initial operation of the Work.

I. CONTRACTOR:
1. Comply with applicable requirements specified in 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 ++
SECTION 01511

TEMPORARY ELECTRICITY

PART 1 - GENERAL

1.1 DESCRIPTION

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

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

C. The temporary service shall conform to applicable provisions of 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, construction trailers, dewatering equipment, and similar usages. Electric space heaters and large welding machines are not included herein.

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

1.2 POWER SOURCE AND SERVICE REQUIRED

A. CONTRACTOR to coordinate supply of temporary power with local power utility.

B. System shall be 240/120 volt, single phase, 60 Hz with sufficient capacity to provide service for construction use by all trades.

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

D. One power center, minimum, shall be provided on each floor.
E. Provide each outlet with circuit breaker protection and comply with ground fault protective requirements of NEC.

F. Work hours are specified under the General Conditions.

G. Provide continuous power for construction site offices.

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

1.3 INSTALLATION

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

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

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

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

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

1.4 REMOVAL

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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.

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.

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 adequate supply service and supply and install meter satisfactory to water utility.
   3. Permission shall be obtained from OWNER for water from hydrants.

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

1.3 COSTS OF INSTALLATION AND OPERATION

A. Pay costs of temporary water service, including costs of installation, maintenance and removal of pipe and equipment.
B. Pay costs for water used by all trades.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

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

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

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

1.5 USE OF OWNER’S EXISTING SYSTEM

A. Use existing system for temporary water for construction.

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

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

1.6 MATERIALS

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

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

C. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval or comply with AAC R18-04-119, Standards for Additives, Materials, and Equipment.

1.7 INSTALLATION

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

B. Maintain to provide continuous service.

C. Modify and extend service as Work progress requires.
D. Locate piping and outlets to provide service convenient to work stations and to avoid interference with traffic and work areas, materials handling equipment, storage area, and work under other contracts.

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

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

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

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

I. Disinfect temporary 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 +++
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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 PERMANENT FACILITIES

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

1.4 INSTALLATION AND REMOVAL

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

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

PART 2 - PRODUCTS

2.1 GENERAL

All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects approval or comply with AAC R18-4-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
SECTION 01522

CONTRACTOR’S FIELD OFFICE AND SHEDS

PART 1 - GENERAL

1.1 DESCRIPTION

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

B. Field Office and Furnishings:
   1. As required by CONTRACTOR, but with sufficient room for project meetings.
   2. Include conference table and chairs sufficient for 20 persons.
   3. Work desk and chair for ENGINEER’s Field Representative.
   4. Automatic heating to maintain 75°F in winter. Automatic cooling to maintain 70°F in summer. Furnish and pay for all fuel/electric.
   6. Six protective helmets for visitor’s use.
   7. Exterior identifying sign.
   8. Other furnishings at CONTRACTOR’S option.
   9. Company sign no larger than 4-feet by 8-feet.

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

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

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NOVEMBER 2016
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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 plant and parking facilities for plant personnel. All parking of construction vehicles shall be in approved lots.

B. Have all paved roads swept by mechanical sweeper, a minimum two 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. Plant 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, refer to Section 01414, Earthmoving and Dust Control.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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. Make no claim against the OWNER for damage or injury resulting from trespass.

C. 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.

D. 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.

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

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

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

H. 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 1-ES2-3 Reservoir site for CONTRACTOR’S employees, material, tools and equipment shall be from the designated construction entrance.
B. Ensure that each of his employees, representatives, delivery persons, suppliers and others acting for CONTRACTOR, shall be subject to the following regulations:

1. CONTRACTOR’S subcontractor’s, suppliers and manufacturer’s employee’s shall not park anywhere other than CONTRACTOR Employee’s Parking Area. The Area shall be designated by the ENGINEER. Prepare and maintain this area, as required.

2. All CONTRACTOR employees shall wear a laminated photograph identification and badge bearing CONTRACTOR’S name, employee’s name, and employee number at all times when the employee is on the site. Badge and Background Check Data form shall be completed by CONTRACTOR and approved by OWNER prior to CONTRACTOR personnel entering the site.

3. Turn over the identification badge to the OWNER upon the individual’s completion of the participation on the project or project completion.

4. OWNER reserves all rights to the approval of all CONTRACTOR, subcontractor, suppliers and manufacturers employees receiving an identification badge.

5. All vehicles, including those belonging to CONTRACTOR, his employees and subcontractors, delivery persons and suppliers entering the facility 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 1-ES2-3 Reservoir 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 OWNER 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. Two project signs identifying at a minimum the project description, OWNER, CONTRACTOR, and contact phone numbers. OWNER shall inform the CONTRACTOR of information requirements.

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 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 16, Electrical.

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 Division 3, Concrete.

1.3 TRANSPORTING, HANDLING AND INSTALLING EQUIPMENT AND MATERIALS

A. Conform to requirements of 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 mill wrights skilled in the handling, setting, aligning, leveling and adjusting of the type of equipment and materials furnished.
2. Use only an oil bath heater to expand couplings, gears, etc. Do not force or drive them on equipment shafts, nor subject them to an open flame or torch.

3. Use proper tools in the assembly of equipment and materials to prevent deforming or marring the surface of shafts, nuts or other parts.

4. 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.

5. 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.

6. Use tools, equipment and materials that shall not damage the structure or equipment.

7. 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.

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. 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 for alignment and adjust to manufacturer’s specifications where necessary.

2. 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.

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 13 and 16 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)

++ END OF SECTION ++
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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 inches
   3. Coating: Black enamel
   4. Size: 2-inches wide by 2-inches high
   5. Shape: Square with rounded corners
   6. Holes: One (1) 3/16-inch hole centered on one end of the tag

B. Engraving:
   1. Text location: CMMS tags shall be engraved with text centered on the tag.
   2. Lettering: Engraved Arial font 1/8-inch high characters. Stamped CMMS tags are not acceptable.
   4. Text quantity: CMMS tags shall accommodate at minimum five (5) lines of engraved text with a minimum of twenty (20) characters per line.
   5. 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 Information</th>
<th>Asset ID</th>
<th>Initial Installed or Purchased Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir 3</td>
<td>Level Sensors</td>
<td>Existing equipment being replaced – As provided by OWNER</td>
<td>As issued by OWNER</td>
<td>2016</td>
</tr>
<tr>
<td>Reservoir 3</td>
<td>Level Transmitters</td>
<td>Existing equipment being replaced – As provided by OWNER</td>
<td>As issued by OWNER</td>
<td>2016</td>
</tr>
<tr>
<td>Reservoir 3</td>
<td>Intrusion switches</td>
<td>Existing equipment being replaced – As provided by OWNER</td>
<td>As issued by OWNER</td>
<td>2016</td>
</tr>
</tbody>
</table>
B. Example CMMS Tag Layout:

![Diagram of CMMS Tag Layout]

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

1.3 DELIVERY

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

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

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

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

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

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

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

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

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

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

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

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

D. Lift heavy components only at designated lifting points.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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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°F. They shall be placed in inside climate storage areas, unless otherwise acceptable to OWNER. When placing orders to suppliers for equipment and controls containing computer chips, electronics and solid-state devices, request and coordinate specific temperature limitations on equipment since cabinets and components stored in the summer can approach temperatures of 200°F.

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

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

G. Do not store products in the structures being constructed, unless approved in writing by the ENGINEER.
H. Lawns, grass plots or other private property shall not be used for storage purposes without written permission of the OWNER or other person in possession or control of such premises.

1.2 PROTECTION

A. Equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage. Each container or piece of equipment shall be clearly marked with CONTRACTOR’S name, project name and location. Equipment shall be stored on raised supports protected from exposure to the elements and shall be kept thoroughly dry at all times. 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, unnecessary UV exposure, and damage:
1. Polypropylene Membrane Liner.

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 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.
1.7 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 ++
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, Demolition.
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 ++
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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 ++
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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°F.
   3. Provide suitable containers for storage of waste materials and debris.
   4. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

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

A. Reservoir Floor and Sidewalls.
   1. Once the reservoir is drained, Contractor shall pressure wash the entire floor area and sidewalls to a point above the maximum water elevation.
   2. Contractor shall dispose of all wash water in a manner that will not damage new and existing construction and will not interfere with construction.
   3. Contractor shall keep the existing liner clean and free from debris during construction. If during the course of construction, construction material that is not NSF certified, such as fuel, oil, solvents, etc., is spilled on the existing liner, that section of liner shall be removed and repaired in accordance with the details provided by the ENGINEER.

B. See Liner Specification 02222 for initial cleaning requirements prior to installing liner system.

C. Final cleaning as specified.

1.5 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. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
      i. Sweep concrete floors broom clean in unoccupied spaces.
      j. Remove tags and labels that are not permanent.
      k. 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.

l. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

m. 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.

n. Maintain the cleaning until OWNER occupies the Project or portion thereof.

o. 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 alignments and reset where needed.
   6. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment.
   7. All adjustments required.

D. 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.

E. No system, 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.

F. 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. CONTRACTOR to coordinate with equipment manufacturer for proper installation and start-up.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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 and instrumentation equipment and systems. This Section supplements, but does not supersede specific testing requirements, found elsewhere in the Contract Documents.

B. CONTRACTOR 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 4-hour work sessions to work through the development of a thorough testing plan. A draft testing, startup and commissioning plan shall be submitted to the OWNER and ENGINEER for review and comment at 30 percent of project construction. A revised draft of the plan shall be submitted to the OWNER and ENGINEER for review and comment at 60 percent of project construction. A final plan shall be submitted at 90 percent of project construction.

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

1.2 QUALITY ASSURANCE

A. CONTRACTOR’S Quality Assurance Manager: Appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise CONTRACTOR’S Quality Assurance Program. The Quality Assurance Manager shall have at least five years of total experience, or experience on at least five separate projects, in managing the startup and performance testing of mechanical, electrical, instrumentation, 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, and instrumentation 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 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 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.

D. References:

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>
</tr>
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<tbody>
<tr>
<td>City of Phoenix</td>
<td>Guidance Manual - 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.
   c. Sample forms for documenting the results of 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:
      a. Field calibration tests\(^1\).
      b. Field pressure tests\(^1\).
      c. Field performance tests\(^1\).
      d. Field operational tests\(^1\).
      (\(^1\)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 1/2in extended tabs and typed description on the tabs for the main sections.
5. Text: Printed data or type written data on 20 pound, minimum, white punched paper. Computer generated data shall be printed by letter quality 150 dpi resolution printers unless approved otherwise.
6. Drawings: Provide with reinforced punched binder tab. Bind in with text; Reduce larger drawings and fold to size of text pages but not larger than 11-inches by 17-inches.

2.3 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

A. Each item of mechanical, electrical, and instrumentation equipment installed under this Contract shall be tested to demonstrate compliance with the performance requirements of the Contract Documents. Each electrical, instrumentation, mechanical, and piping 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. 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 equipment and system and report any unusual conditions to the ENGINEER.
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, 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, 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 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, and pre-startup check out for all 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, 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.

1. 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.
2. 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. 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.

C. 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.

D. 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.

E. Electrical Resistance: Electrical resistance testing shall be in accordance with the requirements of Division 16, Electrical.

F. Pre-Startup Tests: Pre-startup tests shall include the following:
   1. Alignment of equipment.
   2. Tests in accordance with the manufacturers’ recommendations for pre-start preparation and pre-operational check out procedures.
   3. Pre-Startup tests shall conform to the requirements of Section 01751, Starting and Placing Equipment in Operation.

G. 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 one (1) 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. Post-Test Inspection: Once testing has been completed, all machines/equipments 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.
8. After the CONTRACTOR has demonstrated and proven to the ENGINEER that all systems 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.

H. 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 three consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the system shall be available to plant operating personnel for use in normal operation of the Plant.
2. For the purpose of the Operational Availability Demonstration, the system shall be defined as consisting of the following systems and components:
   a. Reservoir Level Transducer and Transmitter.
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 three 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 equipment:
      1) Level transducer/transmitter or any other system component.
   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.
g. High or low reservoir level alarm.

5. The system availability shall be calculated based on the following equation:

\[
A = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} \times 100\%
\]

Where:

- \( A \) = system availability in percent
- \( \text{MTBF} \) = average time interval between consecutive system failures
- \( \text{MTTR} \) = 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 three 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 three 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.
SECTION 01782

RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Maintain and provide the ENGINEER with Record Documents as specified below, except where otherwise specified or modified in Division 2, 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 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. Horizontal and vertical location of underground utilities and
appurtenances referenced to permanent surface improvements.
b. Location of internal utilities and appurtenances concealed in
construction referenced to visible and accessible features of structure.
c. Field changes of dimensions and details.
d. Changes made by Change Order or Field Order.
e. 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-Build 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-Build Drawings that include changes from the previous
week’s As-Build Drawing submittal. Annotations shall include redlined
“clouds” of only those changes from the previous week’s submittal. The redlined As-Build Drawings shall show the actual in-place installation of the items installed under this Contract. The redlined As-Build 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, 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-Build 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-Build 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.
      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 Layout Drawings: These shall include all conduits and wiring furnished under this Contract.

2. In addition to the redlined As-Build Drawings, prepare and submit CADD “.dwg” files, version 2004 or later 2008, for all supplemental drawings used to complete the As-Build Drawings.

3. 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-Build 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-Build 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-Build Drawings will be made on a weekly basis to determine completion for consideration of monthly pay application. Also, make available all As-Build Drawings at all times to the ENGINEER for examination.

3. Prior to Completion of the Work, deliver final As-Build Drawings to ENGINEER. Substantial completion will not be made until satisfactory final As-Build 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-Build 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 ++
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 ++
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SECTION 01784

POST FINAL INSPECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Approximately one year after Substantial Completion, ENGINEER will make arrangements with OWNER and CONTRACTOR for a Post-Final Inspection and will send a written notice to OWNER and CONTRACTOR advising of the date and time of the inspection.

B. After the inspection, ENGINEER will inform CONTRACTOR of any corrections required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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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 01111, Schedule of Completion and Section 01143, Coordination with OWNER’S Operations. Work under this Section shall not start until the Work under Section 01111, Schedule of Completion, 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; and Section 01782, Record Documents. Also, Special Tests as defined under the individual technical specifications, Divisions 0 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/facility 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/facility 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.

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>Commissioning Phases</th>
<th>Commissioning Requirements</th>
<th>Commissioning Duration (Calendar Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Sensors and Field Instruments</td>
<td>All instruments in manual (local) and semi automatic modes of operation</td>
<td>1 Day</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. Perform all Manufacturer recommended preventive maintenance, including instrument calibrations.
      b. Exercise all equipment not in use during Commissioning phase.
      c. Repair all failed equipment.
      d. Periodic check of all equipment alignment, vibration, and noise levels to ascertain conformance with Specifications.
      e. Provide all parts required for equipment repair.
      f. Provide all tools and miscellaneous equipment required for equipment repair.
      g. Administration/logging/documentation of all preventive maintenance and repair work.
      h. Cleanup associated with equipment failure and repair.
      i. Daily cleanup of buildings and site.
      j. Roadway cleanup and maintenance.
   4. Warranty related issues/items.
   5. Other contractual requirements including, but not limited to, incomplete Work list.

C. OWNER’S Responsibilities during the Commissioning Process:
   1. Perform all laboratory analysis required for plant/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 ++
DIVISION 2
SITE WORK
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SECTION 02220

DEMOLITIONS

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 existing HDPE liner, metal roofing system, access stair handrail, exterior piping, and electrical conduits & instrumentation.
   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 and/or use explosives on site.

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. 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. 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.

F. Remove all unused anchor bolts, nails, wire or any other protruding element from concrete walls and floors, particularly where covered by membrane liner. Remove to a depth of ½ IN from finished surface and fill void with non-shrink grout per Section 03305, Concrete.

3.3 MECHANICAL REMOVALS

A. Mechanical removals shall consist of dismantling and removing of existing piping and other appurtenances as specified, shown, or required for the completion of the
Work. Mechanical removals shall include cutting, capping, and plugging as required.

B. Existing process, water, and chemical 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 lines 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.

3.4 ELECTRICAL AND INSTRUMENTATION REMOVALS AND DEMOLITION

A. Electrical removals shall consist of the removal of existing conduits and instrumentation as shown on the Drawings, specified, or required to perform the Work.

3.4 ALTERATIONS

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 walls 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.
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SECTION 02222

MEMBRANE LINER

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 reinforced membrane liner.
   2. Provide all labor, materials, equipment and incidentals to install non-reinforced membrane liner as shown on the Drawings.
      a. The extent of the non-reinforced membrane liner shall be as shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Qualifications: Contractor and fabricator experience:
   1. Contractor installing liner: Experienced in the application of the specified municipal water service reservoir/tank liners for a minimum of 5 years on projects of similar size and complexity. Installed at least 2,000,000 SF of reinforced membrane lining.
   2. Contactor's Supervisor: Employ a supervisor during all phases of the work who has successfully completed manufacturer's contractor training program.
   3. Contractor's Personnel: Employ persons trained for the application of municipal water service reservoir/tank liners.
   5. Provide list of completed projects and references for Contractor installing liner. Include name, address, and telephone number of person to contact regarding previous installation of liners and square footage of lining installed at each location.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM International (ASTM):
      c. D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3).
      d. D746, Standard Test Method for Brittleness Temperature of Plastics and
Elastomers by Impact.
f. D1117, Methods of Testing Nonwoven Fabrics.
g. D1149, Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber (Flat Specimens).
i. D2136, Standard Test Methods for Coated Fabrics - Low-Temperature Bend Test.
k. D3776, Standard Test Method for Mass Per Unit Area (Weight) of Fabric.

   a. D130-11, Geomembrane Materials for Potable Water Applications.

3. Environmental Protection Agency (EPA).

4. National Sanitation Foundation (NSF).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. See Section 01332.
   2. Fabrication and/or layout drawings:
      a. Submit, for Engineer's approval, shop drawings, showing lining sheet layout with proposed size, number, position, and sequence of placing of all factory-fabricated sheets and indicating the location of all field joints and the direction of shop joints on each sheet. Shop drawings shall also show complete details and/or methods for anchoring the lining at top of slope, making field joints, seals at structures, etc.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. NSF 61 Approval Certificate.
      c. Manufacturer's installation instructions.
      d. Technical data concerning physical and chemical properties of the material.
   4. Certifications:
      a. Provide independent lab certification that liner meets membrane performance criteria specified herein. Include factory seam strength certification.
      b. Certification of Contractor's Supervisor: Submit for contractor's supervisor a certificate indicating completion of manufacturer's contractor training program.

B. Miscellaneous:
   1. Submit a written statement from the membrane lining manufacturer that the liner
has been installed properly and is ready for use by the Owner.

2. Test Reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS AND MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Polypropylene manufacturers and fabricating suppliers:
      b. Carlisle.
      c. Or, Approved equal.

   2. Geotextile fabrics:
      a. MIRAFI.
      b. Crown Resources.
      c. Or, Approved equal.

2.2 MINIMUM DESIGN CRITERIA

A. Provide liner that meets or exceeds the following criteria:
   1. Fabric reinforced liner (polypropylene):

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHODS</th>
<th>TEST VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D751, Method C</td>
<td>0.045 IN ±10 %</td>
</tr>
<tr>
<td>Strength:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warp</td>
<td>ASTM D751</td>
<td>250 LB</td>
</tr>
<tr>
<td>Fill</td>
<td>Grab Method</td>
<td>250 LB</td>
</tr>
<tr>
<td>Tear:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warp</td>
<td>ASTM D751</td>
<td>70 LB</td>
</tr>
</tbody>
</table>

   2. Non-reinforced liner (polypropylene):

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHODS</th>
<th>TEST VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D199</td>
<td>0.045 IN ±10 %</td>
</tr>
<tr>
<td>Strength:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warp</td>
<td>ASTM D638</td>
<td>96 LB</td>
</tr>
<tr>
<td>Fill</td>
<td>Grab Method</td>
<td>96 LB</td>
</tr>
<tr>
<td>Tear:</td>
<td>ASTM D1004</td>
<td>18 LB</td>
</tr>
</tbody>
</table>

2. All factory and field seams (joints): After 12 days, a seam strength of 250 LB when tested in accordance with ASTM D751, Grab Method (using 4 IN wide
specimens having a length of 10 IN plus the seam width). The distance between the jaws of the testing apparatus at the start of the test must be 8 IN plus the seam width and shall have sufficient strength in peel that they fail by delamination from the scrim rather than in the plane of the seam.

B. Provide geotextile fabric (100% polypropylene) that meets or exceeds the following criteria:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHODS</th>
<th>TEST VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D1777</td>
<td>120 mils</td>
</tr>
<tr>
<td>Weight</td>
<td>ASTM D3776</td>
<td>12 OZ/SY</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D1682</td>
<td>300 LBS</td>
</tr>
<tr>
<td>Elongation at Failure</td>
<td>ASTM D1682</td>
<td>50% min, 100% max</td>
</tr>
<tr>
<td>Burst Strength</td>
<td>ASTM D3786</td>
<td>500 psi</td>
</tr>
<tr>
<td>Coefficient of Normal permeability</td>
<td>5 IN constant head</td>
<td>0.3 cm/sec</td>
</tr>
<tr>
<td>Vertical Water Flow</td>
<td>5 IN constant head</td>
<td>75 gpm/sf</td>
</tr>
<tr>
<td>Equivalent Opening Size</td>
<td>CW-02215 US Std. Sieve</td>
<td>80 - 100</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D4833</td>
<td>140 LB</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>ASTM D1117</td>
<td>105 LB</td>
</tr>
</tbody>
</table>

2.3 LINING MATERIALS AND FACTORY FABRICATION

A. Provide membrane lining material consisting of 45 mil fabric-reinforced (scrim) polypropylene material of new first quality products designed and manufactured specifically for potable water use. Non-reinforced polypropylene material can be used only at column boots. However, the use of column boots is not permitted for this reservoir.

B. Fabricate polypropylene utilized for encapsulation of the scrim, from a composition of high-quality ingredients, suitably compounded.

C. Other Requirements:
   1. Provide factory seams having a minimum of 3 IN scrim to scrim overlap when made by the heat welded method.
   2. Identify each factory-fabricated sheet with prominent, unique indelible identifying markings indicating the sheet number, date of fabrication, and proper direction of unrolling and/or unfolding to facilitate layout and positioning in the field. Package each factory-fabricated sheet individually in a heavy cardboard or wooden crate, fully enclosed and protected to prevent damage to it during shipment. Identify crate the same fashion as the sheet within and show the date of shipment.
3. Liner shall be white or light colored. If light colored, provide color samples for owner’s approval.
4. Provide date of manufacture of polypropylene roll goods.

D. Provide geotextile underliner fabric of polyester or polypropylene non-woven spunbound material.

E. Polyester Rope Material:
   1. Polyester rope material shall be used as a part of the batten seal system to secure the liner to vertical walls and ledges of side slopes or as required.

F. Stainless Steel battens:
   1. As per ASTM A167 (Type 316).
   2. Stainless steel 1/4 IN x 2 IN batten shall be used to provide a water tight seal for the following:
      a. Vertical ringwalls.
      b. Side-slope.
      c. Stairs.
      d. Column bases.
      e. Overflow structure.
      f. Inlets and outlets.
      g. Reservoir drain pipe.
      h. As required.
   3. All stainless steel bars coming in contact with any portion of the membrane liner shall have all edges and corners ground smooth including drill holes.

G. Nuts, bolts, washers and anchors for batten system:
   1. Stainless steel nuts and bolts – ASTM A193 and A194 (Type 316).
   2. Bolts and washers shall be used at 6 IN centers.
   3. Epoxy anchors to be 316 stainless steel. Epoxy shall be NSF 61 certified.
   4. Expansion anchors are not acceptable.

H. Anchors shall be placed at 6 IN intervals for battens, in all locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cleaning: The reservoir bottom and side slopes to receive the liner shall be brush blasted to provide a smooth surface free of sharp objects and metal shavings (including those which may result from metal fastening installation on the roof).
   1. The reservoir shall be cleaned prior to placing the liner underlay material.
   2. Contractor shall notify the Engineer and Owner a minimum of two working days prior to the installation of the liner system for on site inspection of the Contractor’s cleaning efforts.
a. See paragraph 3.4.B.1 of this specification for cleaning approval requirements.

3. Any additional cleaning or floor preparation, including scraping, grinding, grouting or caulking, deemed necessary by the Engineer and/or manufacturer representative, shall be completed by the Contractor at no additional expense to the project.

4. Any additional geotextile underliner fabric deemed necessary by Engineer or Manufacturer’s Representative shall be provided and installed at no additional expense to the project.

B. Liner Installation:

1. Joints. Utilize joints and lap joints to seal factory-fabricated sheets of membrane liners together in the field. Make all field joints between sheets of membrane liners on a supporting smooth surface and sealing machine shall be used to make the joints at sealing temperature as recommended by the manufacturer. Form lap joints by lapping the edges of sheets a minimum of 3 IN scrim-to-scrim. Wipe contact surfaces of the sheets clean to remove all dirt, dust, moisture, or other foreign materials. Fabricate seams by heating the material to a temperature sufficient to melt both layers of material to create a bond. Smooth any wrinkles and seal any cut edges of the membrane liner to prevent wicking.

C. Repairs:

1. Patch any necessary repairs to the membrane with a piece of the membrane lining material by heating both layers of material to a sufficient temperature to melt both layers and immediately rolled together to produce a seam. Extrusion welding should typically be used to seal any exposed scrim on the edges of patches.

3.2 REPAIR MATERIALS AND INSTRUCTION

A. Provide Owner with at least 100 SF of reinforced liner material for making repairs after the project is complete.

B. Instruct Owner on the recommended techniques for repairing holes or rips in the liner. Provide written directions on how to make a repair.

3.3 FIELD TESTING

A. Field testing of the liner shall be performed as indicated in Table below.
### 3.4 FIELD QUALITY CONTROL

A. Ensure all joints, upon completion of the work, are tightly bonded. Any membrane surface showing injury due to scuffing, penetration by foreign objects, or distress from other causes shall, as directed by the Engineer, be replaced or repaired with an additional piece of membrane liner of the proper size at no additional cost to Owner. Air lance all joints to detect poor joints and repair as necessary.

B. Employ and pay for services of the manufacturer's field service representative(s), fully commissioned and authorized by the manufacturer (representative must be employed by liner manufacturer), to do the following:
   1. Approve condition of reservoir bottom and side slopes prior to installation of reinforced and non-reinforced membrane liner as an acceptable surface for placement of the liner.
   2. Instruct Contractor in manufacturer approved methods for installing and testing reinforced and non-reinforced membrane liner.
   3. Observe and supervise installation of the reinforced and non-reinforced membrane liner to ensure Contractor's conformance with the manufacturer's approved installation technique.
      a. Manufacturer’s Representative must be on site full time during the entire installation process.
      b. Provide weekly progress report for liner installation including total number of square feet of liner installed, copies of all field seam testing data, general list of cleaning and floor preparation efforts performed, and identification of any damaged areas in the liner or underlay material.
   4. Observe all field seam testing.
5. Provide Owner with a written statement from the membrane lining manufacturer that the liner has been installed properly and is ready for use by the Owner.

6. Utilize only materials and procedures recommended by the liner manufacturer.

### 3.4 WARRANTY

A. The liner manufacturer shall warrant, the polypropylene lining materials, against manufacturing defects and material degradation for a period of 20 years from date of final acceptance. The manufacturer shall replace any material that fails due to manufacturer defects or material degradation within the warranty period.

B. The Contractor shall furnish the Owner with a 5 year written warranty covering fabrication and installation of liner system.

++ END OF SECTION ++
DIVISION 3
CONCRETE
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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. Piping.
   5. Grating and floor plate.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and
   recommendations of the following, except as otherwise shown and specified.
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete
      Structures.
   3. ACI 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
   4. ASTM A 36, Specification for Structural Steel.
   5. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron
      and Steel Products.
   6. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel
      Hardware.
   7. ASTM A 193, Standard Specification for Alloy-Steel and Stainless Steel
      Bolting Materials for High-Temperature Service.
   8. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi
      Tensile Strength.
9. ASTM A 484/A 484M, Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
10. ASTM A 525, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
22. NSF/ANSI 61, Drinking Water System Components Health Effects.
24. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

B. Post-installed concrete anchors, inserts, and related materials shall be ICC Evaluation Service (ICC-ES), UL, or FM approved.

C. Qualifications:
   1. Engineer for CONTRACTOR designed post-installed anchors: Professional structural engineer licensed in the State of Arizona.

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 current ICC-ES, UL, or FM reports certifying load carrying capacities and installation requirements for the anchorage devices.


5. For CONTRACTOR designed post-installed anchors, submit the following:
   a. Certification that anchors meet all requirements indicated in this Specification.
   b. Shop Drawings and engineering design calculations:
      1) Indicate design load to each anchor.
      2) Type of post-installed anchor used.
      3) Diameter and embedment depth of each anchor.
      4) Indicate compliance with ACI 318 and ACI 350 Appendix D.
      5) Sealed by a professional engineer registered in the State of Arizona.
      6) ENGINEER will review for general compliance with Contract Documents.

   a. Indicate manufacturer’s certification of installer for each type of approved post-installed anchor to be used on the Project.

B. Samples: Submit for approval the following:
   1. Representative samples of bolts, anchors and inserts as may be requested by ENGINEER. Review will be for type and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, concrete anchor, or concrete insert is not shown on the Drawings, provide the following:
   1. For anchor bolts (cast-in-place), provide the size, length and capacity required to carry the design load based on the values and requirements given in the Phoenix Building Code.
   2. For concrete anchors (adhesive types) and concrete inserts, provide the size, length, type, and capacity required to carry the design load based on the values and requirements given in the ICC 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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<tr>
<th>Bolt diameter (Inches)</th>
<th>Min Shear (Pounds)</th>
<th>Min Pull-Out Load (Pounds)</th>
</tr>
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<tbody>
<tr>
<td>1/2</td>
<td>5,000</td>
<td>7,600</td>
</tr>
<tr>
<td>5/8</td>
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<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, either an adhesive anchor or anchor bolt shall be used. In masonry, where a concrete anchor is indicated, only anchor bolts and adhesive anchors shall be used.

B. Anchor Bolts (cast-in-place)
   1. Shall be used where indicated and may be used where concrete anchors are indicated.
   2. Where an anchor bolt is indicated, only a cast-in-place anchor bolt shall be used, unless another anchor type is accepted by the ENGINEER.
   3. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.

C. Adhesive Anchors:
   1. Use wherever concrete anchors are shown on the Drawings.
   2. Use where subject to vibration or where buried or submerged.
   3. Use for pipe supports.
   4. Use in concrete and masonry.
   5. Shall not be used in ceilings.
   6. Shall not be used for pipe hangers.

D. Concrete Inserts:
   1. Use only where indicated.
   2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.
2.3 MATERIALS

A. Anchor Bolts:
   1. Provide stainless steel bolts complying with ASTM F 593, AISI Type 316 headed or non-headed type with nitronic 60 stainless steel nuts and locknuts, unless otherwise indicated.
   2. In buried or submerged locations, provide stainless steel bolts complete with washers complying with ASTM F 593, AISI Type 316 and with nitronic 60 stainless steel nuts and locknuts. Other AISI types may be used subject to ENGINEER’S approval.
   3. For equipment, provide anchor bolts, which meet the equipment manufacturer's recommendations for size, material, and strength.
   4. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.
   5. Locate and accurately set the anchor bolts using templates or other devices as required.
   6. Protect threads and shank from damage during installation of equipment and structural steel.
   7. Comply with manufacturer’s required embedment length and necessary anchor bolt projection.

B. Adhesive Anchors:
   1. Unless otherwise indicated in the Drawings, provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
   2. In buried or submerged locations, provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
   3. Anchors shall be of the size required for the concrete strength specified.
   4. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer’s instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt, unless noted otherwise on the Drawings.
   5. Product and Manufacturer: Provide one of the following:
      a. SET XP, as manufactured by Simpson Strong-Tie.
      b. Epcon S7, as manufactured by ITW Ramset/Redhead.
      c. HIT-HY 200, as manufactured by Hilti.
      d. HIT-RE 500-SD, as manufactured by Hilti.
      e. PURE110+, as manufactured by Powers Fasteners.
      f. Or equal.

C. Concrete Inserts:
1. For piping, grating, floor plate and masonry lintels, provide malleable iron inserts. Comply with Federal Specification WW-H-171E (Type 18). Provide those recommended by the manufacturer for the required loading.

2. Finish shall be black.

3. Product and Manufacturer: Provide one of the following:
   a. Figure 282, as manufactured by ITT Grinnell.
   b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
   c. Or equal.

D. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by ENGINEER.

E. Expansion anchors will not be allowed.

F. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this Section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects Approval or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which 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.

B. Periodic or continuous Special Inspection of post-installed anchors shall be provided as required by the Building Code, ICC-ES Evaluation Reports and as specified by the ENGINEER. Special Inspection shall be performed by personnel independent of the manufacturer or CONTRACTOR.
   1. CONTRACTOR shall submit a statement of responsibility to the OWNER acknowledging an awareness of the Special Inspection requirements for the Project. The statement shall specifically acknowledge that the CONTRACTOR has made provisions in the Project construction schedule to allow time for completion of all Special Inspections.

3.2 INSTALLATION

A. Assure that embedded items are protected from damage and are not filled in with concrete.
B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

C. For the adhesive anchors and adhesive material, comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar. Properly clean out the hole utilizing a non-metallic fiber bristle brush and compressed air to remove all loose material from the hole, prior to installing adhesive material.

D. Adhesive anchor manufacturer's representative shall observe and demonstrate the proper installation procedures for the adhesive anchors and adhesive material at no additional expense to OWNER. Each installer shall be certified in writing by the manufacturer to be qualified to install the adhesive anchors.

3.3 CLEANING

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

3.4 FIELD QUALITY CONTROL

A. Employ a testing laboratory to perform field quality testing of installed anchors. Field engineer is to determine the level of testing which is required for the various types of adhesive anchors and anchor bolts. A minimum of ten percent of the adhesive anchors and reinforcing bars are to be tested to 50 percent of the ultimate tensile capacity of the adhesive anchor or reinforcing bar.

B. If failure of any of the adhesive anchors or reinforcing bars occurs, testing the remaining 90 percent will be required and the costs involved belong to the CONTRACTOR. Responsibility belongs to CONTRACTOR to correct improper workmanship, remove and replace, or correct as directed by the ENGINEER, all adhesive anchors or bars found unacceptable or deficient, at no additional cost to the OWNER.

D. The independent testing and inspection agency shall complete a report on each area of the Work where concrete anchors are installed. The report shall summarize the observations made by the inspector and be submitted to ENGINEER.

E. Provide access for the testing agency to places where work is being produced so that required inspection and testing can be accomplished.

++ END OF SECTION ++
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SECTION 03305

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 concrete, reinforcement, and related materials.
   2. The Work includes:
      a. Providing concrete consisting of portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported placed, finished, and cured.
      b. Fabrication and placement of reinforcement, including ties and supports.
      d. Building into the concrete all sleeves, frames, anchors, inserts, and other items required to be embedded in the concrete.
      e. Providing openings in the concrete as required to accommodate Work under this and other Sections.

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 all concrete.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
   1. Concrete Testing Service:
      a. Employ acceptable testing laboratory to perform materials evaluation, testing, and design of concrete mixes.
      b. OWNER will employ a separate testing laboratory to perform field quality control sampling and testing on concrete delivered to and placed at the site. Full access shall be provided by CONTRACTOR to personnel of OWNER'S testing laboratory to Work and shall provide all assistance, including labor and equipment, necessary to facilitate testing and sampling.
   2. Certificates, signed by concrete producer and CONTRACTOR, may be submitted in lieu of material testing when acceptable to ENGINEER.
3. OWNER'S testing laboratory will perform field quality control sampling and testing during concrete placement, as follows:
   b. Slump: ASTM C 143, one test for each load at point of discharge.
   c. Air Content: ASTM C 231.
   d. Compressive Strength: ASTM C 39, one set of compression strength specimens for each 50 cubic yards or fraction thereof or for each 2,500 square feet of surface area or fraction thereof for each class of concrete placed in any one day.
      1) Test one specimen at seven days and two specimens at 28 days.
      2) When the total quantity of concrete is less than 50 cubic yards, the strength tests may be waived by ENGINEER following review and acceptance of submitted field experience indicating evidence of satisfactory strength.
      3) Slump and air content testing shall be conducted on each sample from which compressive strength specimens are taken.

4. Report test results in writing to ENGINEER on same day tests are made.

B. Standard Specifications and Details:
   1. Conform to all applicable requirements of Sections 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.

C. Reference Standards: Comply with applicable provisions and recommendations of the latest editions of the following, except as otherwise shown or specified.
   1. ACI 224, Control of Cracking in Concrete Structures.
   2. ACI 301, Specifications for Structural Concrete.
   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 315, Details and Detailing of Concrete Reinforcement.
   8. ACI 318, Building Code Requirements for Structural Concrete.
   10. ACI 347, Guide to Formwork for Concrete.
   12. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
   13. ASTM A 615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   14. ASTM C 33, Specification for Concrete Aggregates.
15. ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
17. ASTM C 143, Test Method for Slump of Hydraulic Cement Concrete.
19. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.
20. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
23. ASTM C 494, Specification for Chemical Admixtures for Concrete.

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. Submit the following Shop Drawings:
1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
2. Concrete placement plans showing the location and type of all joints.
3. Drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI 315 and ACI SP-66. For walls, show elevations to a minimum scale of 1/4-inch to 1 foot. Show bar schedules, stirrup spacing, splice lengths, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement.
4. 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 in accordance with ACI 301, Section 4. Submit written report to ENGINEER for each proposed concrete mix at least 15 days prior to start of Work. Do not begin concrete production until mixes have been reviewed and are acceptable to ENGINEER. Mix designs may be adjusted when material characteristics, job conditions, weather, test results, or other circumstances warrant. Do not use revised concrete mixes until submitted to and accepted by ENGINEER.
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.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

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.

B. 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.

C. Store concrete reinforcement materials to prevent damage and accumulation of foreign material including dirt and excessive rust. Store on framework or blocking such that no materials come in contact with ground. Space framework or blocking supports to prevent excessive deformation of stored materials.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II.

B. Aggregates: ASTM C 33.
   1. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank run sand, and manufactured sand are not acceptable.
   2. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
      a. Crushed stone, processed from natural rock or stone.
      b. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.

C. Coarse Aggregate Size: ASTM C 33, Nos. 57 or 67, unless permitted otherwise by ENGINEER.

D. Water: Clean, potable.

F. Water-Reducing Admixture: ASTM C 494, Type A. Only admixtures which have been tested and accepted in mix designs shall be used.

G. Water Reducing and Set Adjusting Admixtures: ASTM C 494, Type D and E. Only admixtures which have been tested and accepted in mix designs shall be used.

H. High Range Water-Reducing Admixture: ASTM C 494, Type F/G. Only admixtures which have been tested and accepted in mix designs shall be used.

I. Calcium Chloride or admixtures containing chloride ions shall not be used.

2.2 CONCRETE MIX

A. General
   1. Normal weight: 145 pounds per cubic foot.
   2. Use air-entraining admixture in all concrete: provide not less than four percent nor more than eight percent entrained air for concrete exposed to freezing and thawing, and from three percent to five percent for other concrete.

B. Proportioning and Design of Type “1” Mix:
   1. Minimum compressive strength at 28 days: 4,000 psi.
   2. Maximum water cement ratio by weight: 0.45.
   3. Minimum cement content: 564 pounds per cubic yard.

D. Proportioning and Design of Type “3” Mix:
   1. The requirements for Type “1” concrete shall be met except that slump shall be increased by the use of a high range water-reducer.

E. Slump Limits:
   1. Proportion and design mixes to result in concrete slump at the point of placement of not less than 1-inch and not more than 4-inches.
   2. Where high range water reducers are used, slump prior to addition of admixture shall not exceed 3-inches. Slump after addition of admixture shall not exceed 8-inches at point of placement.

F. Adjustment to Concrete Mixes:
   1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, job conditions, weather, test results, or other similar circumstances.
2. Laboratory test data for adjusted concrete mix designs, including compressive strength test results, shall be submitted to ENGINEER for review.
3. Adjusted mix designs shall be implemented only with the approval of the ENGINEER.
4. Adjustments to the concrete mix designs shall result in no additional costs to the OWNER.

2.3 FORM MATERIALS

A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. CONTRACTOR is responsible for the design of the formwork system, which shall be designed to safely resist all applied loads including pressures from fluid concrete and construction loads.

B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces as required by ACI 301.

C. Unexposed Concrete Surfaces: Material to suit project conditions.

D. Provide 3/4-inch chamfer at all external corners. Not required at re-entrant corners, unless indicated otherwise.

E. 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-inches from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a uniform, circular hole no larger than 1-inch diameter in the concrete surface when removed.
   3. Ties for exterior walls, below grade walls, and walls subject to hydrostatic pressure shall have waterstops.
   4. Wire ties are not acceptable.

2.4 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60 deformed bars.

B. Supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.

2. For slabs on grade, use precast concrete blocks (4-inches square minimum with compressive strength equal to or greater than the surrounding concrete) or supports with sand plates or horizontal runners where base materials will not support chair legs.

3. For all concrete surfaces, where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic protected or stainless steel legs complying with the requirements of CRSI, “Manual of Standard Practice”.

4. Provide precast concrete supports over waterproof membranes.

C. Drilled Dowels:
   1. Adhesive material for drilled dowels shall be a vinylester resin, epoxy resin, urethane methacrylate or vinyl urethane resin specifically formulated for the application, moisture condition, application temperature, and orientation of the hole to be filled. Polyester resins shall not be used. The resin shall be a high modulus, moisture insensitive type packaged in a cartridge dispensing system with a static mixing nozzle.

   2. The adhesive system shall be certified by test to develop a pullout resistance in the specified concrete equal to 125 percent of the yield strength of the dowel bar when embedded to the manufacturer’s recommended depth. Drilled dowels shall be embedded a minimum of 12 times the nominal bar diameter into sound concrete.

   3. Products and Manufacturers: Provide one of the following:
      a. SET XP, as manufactured by Simpson Strong-Tie
      b. Epcon S7, as manufactured by ITW Ramset/Redhead.
      c. HIT-HY 200, as manufactured by Hilti
      d. HIT-RE 500-SD, as manufactured by Hilti.
      e. PURE110+, as manufactured by Powers Fasteners.
      f. Or equal.

2.5 RELATED MATERIALS

A. Waterstops:
   1. Polyvinyl Chloride Waterstops:
      a. Waterstops shall meet the requirements of CRD-C 572. No reclaimed or scrap material shall be used.
      c. Provide waterstops with a minimum of seven ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be a minimum 1/8-inch in height.
      d. Construction Joints: Waterstops shall be 6-inch wide flatstrip type.
      e. Expansion Joints: Waterstops shall be 9-inch wide centerbulb type.
f. Products and Manufacturers: Provide one of the following:
   1) W.R. Meadows, Inc.
   2) A.C. Horn, Inc.
   3) Or equal.

2. Hydrophilic Waterstops:
   a. 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.
   b. Waterstop material shall be composed of resins and polymers which absorb water and cause a completely reversible and repeatable increase in volume.
   c. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
   d. Select material in accordance with manufacturer’s recommendations for the type of liquid to be contained.
   f. Location of the hydrophilic waterstops shall be as shown on the Drawings or where approved by the ENGINEER.
   g. Products and Manufacturers: Provide one of the following:
      1) Duroseal Gasket, by BBZ USA, Inc.
      2) Adeka Ultraceal MC-2010M, by Asahi Denka Kogyo K.K.
      3) Or equal.
   h. Hydrophilic Sealant shall adhere firmly to concrete, metal and PVC in dry or damp condition and be indefinitely elastic when cured.
      1) Products and Manufacturers: Provide one of the following:
         a) Duroseal Paste, by BBZ USA, Inc.
         b) Adeka Ultraceal P-201, by Asahi Denka Kogyo K.K.
         c) SikaSwell S, by Sika Corp.
         d) Or equal.

E. Membrane-Forming Curing compound: ASTM C 309, Type I.

F. Epoxy Bonding Agent:
   1. Two-component epoxy resin bonding agent.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 32, Hi-Mod LPL, by Sika Corp.
      b. Eucopoxy LPL, by the Euclid Chemical Company.
      c. Or equal.

G. Epoxy-Cement Bonding Agent:
   1. Three component blended epoxy resin-cement bonding agent.
   2. Products and Manufacturers: Provide one of the following:
      a. Sika Armatec 110 EpoCem, by Sika Corp.

c. Or equal.

H. Joint Fillers, Sealant and Backer Rod:
2. Joint Sealant: Where expansion joints are indicated to be subject to being submerged by water, joint sealant shall be a two part polyurethane type sealant conforming to the requirements of ASTM C 920, Type M, Class 25. The sealant shall be formulated for use in continuously submerged conditions and shall be used only with the manufacturer’s recommended primer.
   a. Products and Manufacturer’s: Provide one of the following:
      1) Permapol RC-270 Reservoir Sealant by Products Research and Chemical Corp.
      2) Sikafolex-2c by the Sika Corp.
      3) Or Equal.
3. Backer Rod: Extruded closed-cell polyethylene foam rod compatible with the sealant material. The backer rod shall be 1/8-inch larger in diameter than the joint width for joints less than 3/4-inch wide and 1/4-inch larger in diameter than the joint width for joints 3/4-inch wide and wider.

2.6 GROUT
A. Non-shrink Grout:
1. Prepackaged, non-metallic, cementitious grout requiring only the addition of water at the job site.
3. Products and Manufacturers: Provide one of the following:
   a. NS Grout by the Euclid Chemical Company.
   b. Set Grout by Master Builders, Inc.
   c. NBEC Grout by Five Star Products, Inc.
   d. Or equal.

B. Epoxy Grout:
1. Prepackaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
2. Minimum seven-day compressive strength: 14,000 psi, when tested in accordance with ASTM C 579.
3. Products and Manufacturers: Provide one of the following:
   a. Euco High Strength Grout by the Euclid Chemical Company.
   b. Sikadur 42, Grout Pak by the Corp.
   c. Five Star Epoxy Grout by Five Star Products, Inc.
   d. Or equal.

C. Cement-Sand Grout:
1. Grout mix shall consist of cement, fine and coarse aggregates, water and admixtures meeting the requirements previously specified for similar materials in concrete.

2. Proportion and mix grout as follows:
   a. Minimum cement content: 564 pounds per cubic yard.
   b. Maximum water-cement ratio: 0.45.
   d. Maximum coarse aggregate size: 1/2-inch, unless indicated otherwise.
   e. Minimum 28-day compressive strength: 4,000 psi.

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 FORMWORK

A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Provide openings in formwork to accommodate Work of other trades. Accurately place and securely support items required to be built into formwork.

C. Clean and adjust forms prior to concrete placement. Apply form release agents or wet forms, as required. Retighten forms during and after concrete placement if required to eliminate cement paste leaks.

D. Removal of Formwork:
   1. Conform to the requirements of ACI 301 and ACI 347, except as otherwise specified.
   2. Formwork or shoring shall not be removed until supported concrete members have acquired a minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated herein.
   3. Removal time for all formwork will be subject to approval of ENGINEER.
   4. Form tie holes shall be repaired following the requirements of ACI 301.

3.3 REINFORCEMENT, JOINTS, AND EMBEDDED ITEMS
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 support.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice and other materials which act to reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement. Locate and support reinforcing by means of 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 with ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Reinforcement shall not be secured to formwork with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

D. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcement more than 2-inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

E. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

F. Concrete shall not be placed until the reinforcement is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected. Notify ENGINEER a minimum of two working days prior to proposed concrete placement.

G. Joints:
   1. Provide construction, isolation, expansion, and control joints as indicated or required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking.
   2. The location of all joints shall be as approved by the ENGINEER.
   3. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously placed concrete to a full amplitude of 1/4-inch.

H. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by
cast-in-place concrete. Use setting diagrams, templates and instructions provided under other Sections for locating and setting. Refer also to Paragraph 1.1.B, above. Uncoated aluminum items shall not be embedded in concrete. Where aluminum items come in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.

I. Drilled Dowels
1. Drilled dowels shall consist of reinforcing dowels set in an epoxy adhesive in a hole drilled into hardened concrete.
2. Holes shall be drilled to the epoxy 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 epoxy.
4. Existing reinforcement 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 reinforcement. Adjusted hole locations shall be subject to ENGINEER’S approval.
5. The hole shall be cleaned using a non-metallic fiber bristle brush and blown out with clean, dry compressed air to remove all dust and loose particles.
6. Epoxy 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 epoxy 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 epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.
8. Drill holes, install epoxy and dowels and cure epoxy in accordance with epoxy manufacturer’s recommendations and using epoxy manufacturers standard tools and accessories.

3.4 CONCRETE PLACEMENT

A. Job-Site Mixing: Use drum type batch machine mixer, mixing not less than 1-1/2 minutes for one cubic yard or smaller capacity. Increase mixing time a minimum of 15 seconds for each additional cubic yard or fraction thereof.

B. Ready-Mixed Concrete: Comply with the requirements of ASTM C 94.

C. Concrete Placement:
1. Place concrete in a continuous operation within planned joints or sections complying with the requirements of ACI 304.
2. Do not begin placement until work of other trades affecting concrete is completed.
3. Wet concrete and subgrade surfaces to a saturated surface dry condition immediately prior to placement of concrete.
4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
5. Take care to avoid separation of the concrete mixture during transportation and placement. Concrete shall not be permitted to free fall for a distance greater than four feet during placement.
6. Concrete placement shall be completed within 90 minutes of the addition of water to the dry ingredients.

D. Consolidate placed concrete in accordance with ACI 309 using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around reinforcement and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or reinforcement shall not be permitted.

E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement, and curing.
1. In hot weather comply with the requirements of ACI 305.
2. In cold weather comply with the requirements of ACI 306.

3.5 QUALITY OF CONCRETE WORK

A. Make all concrete solid, compact, smooth and free of laitance, cracks and cold joints.

B. All concrete for liquid retaining structures, and all concrete in contact with earth, water or exposed directly to the elements shall be watertight.

C. 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. Patches or plastering will not be acceptable.

D. Repair, removal and replacement of defective concrete as ordered by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by use of moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed.
Provide protection as required to prevent damage to exposed concrete surfaces. The total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.7 FINISHES

A. Slab 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. Use a wood float only. 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, re-float the surface to a uniform, smooth, granular texture. All slab surfaces shall receive a float finish. Provide additional trowel finishing as required below.
   2. 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.
   3. 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 which would telegraph through applied floor covering system.
   4. Use trowel finish for the following:
      a. Interior exposed slabs, unless otherwise shown or specified.
      b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown on the Drawings.

B. Formed Finish:
   1. Provide a smooth form concrete finish at all exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces also include all interior water bearing surfaces of tanks, whether directly visible or not. All surfaces shall be considered as exposed, unless buried or covered with a permanent structural or architectural material. After form removal, patch all form tie holes and defects in accordance with the requirements of ACI 301. Remove all fins exceeding 1/8-inch in height. Where surface is to be coated or to receive further treatment, remove all fins flush with concrete surface.
   2. Provide rough form finish at all unexposed surfaces. After form removal, patch all form tie holes and defects in accordance with the requirements of ACI 301. Remove all fins exceeding 1/2-inch in height.

3.8 GROUT PLACEMENT
A. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the specified requirements do not proceed until ENGINEER provides clarification.

B. Dry-packing will not be permitted, unless indicated otherwise.

C. Manufacturers of proprietary products shall make available upon 72 hours notification the services of qualified, full-time employee to aid in assuring proper use of the product under job conditions.

D. Placing grout shall conform to the temperature and weather limitations described in Article 3.4, above.

++ END OF SECTION ++
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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. 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>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

Concrete fill greater than 4-inches thick.

- Type “1” Concrete in accordance with Section 03305, Concrete.

Any application not listed above, where grout is called for on the Drawings.

- Non-shrink Class I, unless noted otherwise

### 1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavy-Weight and Mass Concrete.
2. ACI 301, Specification for Structural Concrete (Includes ASTM Standards referred to herein).
3. ASTM C 33, Specification for Concrete Aggregates.
10. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
11. ASTM C 937, Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.
16. NSF/ANSI 61, Drinking Water System Components Health Effects.

B. Field Tests:
1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the ENGINEER to ensure continued compliance with these specifications. The specimens will be made by the ENGINEER or its representative.
2. Compression tests and fabrication of specimens for non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, 28 days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, and each earlier time period as appropriate.
4. The cost of all laboratory tests on grout will be borne by the OWNER, but CONTRACTOR shall 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. 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 and II grouts.
2. Submit certified testing lab reports for ASTM C 1107, Grade B and Grade C (as revised herein) requirements for Class I and II grouts tested at a fluid consistency for temperatures of 45, 73.4, 90°F with a pot life of 30 minutes at fluid consistency.
3. Submit certification that materials meet specification requirements for nonproprietary materials.
4. Submit certifications that all grouts used on the project are free of chlorides or other chemicals causing corrosion.
5. Manufacturer's specifications and installation instructions for all proprietary materials.
6. Certificate of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-4-119, in accordance with Section 01600 requirements.
7. Grout mix shall be provided by CONTRACTOR and submitted to the ENGINEER for approval. Once approved, ENGINEER shall submit to ADWR for review.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Grout materials from manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.

B. Storage of Materials: Grout materials shall be stored in a dry shelter and shall be protected from moisture.

PART 2 - PRODUCTS

2.1 GROUTS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.

B. Class I Non-Shrink Grout:
   1. Class I non-shrink grouts shall have a minimum 28 day compressive strength of 7000 psi. This grout is for precision grouting and where water tightness and non-shrink reliability in both plastic and hardened states are critical. Refer to areas of application as specified herein.
   2. Shall meet the requirements of ASTM C 1107 Grade C and B (as modified below) when tested using the amount of water required to achieve the following properties:
      a. Fluid consistency (20 to 30 seconds) in accordance with ASTM C 939
      b. At temperatures of 45, 73.4, and 95°F.
   3. The length change from placement to time of final set shall not have a shrinkage greater than the amount of expansion measured at 3 or 14 days. The expansion at 3 or 14 days shall not exceed the 28-day expansion.
   4. The non-shrink property is not based on a chemically generated gas or gypsum expansion.
   5. Fluid grout shall pass through the flow cone, with a continuous flow, one hour after mixing.
   6. Product and Manufacturer: Provide one of the following:
      a. Masterflow 928, as manufactured by Master Builders, Inc.
      b. Five Star Grout, as manufactured by Five Star Products, Inc.
      c. Hi-Flow Grout, as manufactured by the Euclid Chemical Company.
c. SikaGrout 328, as manufactured by Sika Corporation

e. Or equal.

C. Class II Non-Shrink Grout:

1. Class II non-shrink grouts shall have a minimum 28 day compressive strength of 7000 psi. This grout is for general purpose grouting applications as specified herein.

2. Shall meet the requirements of ASTM C 1107 and the following requirements when tested using the amount of water required to achieve the following properties:
   a. Flowable consistency (140 percent flow on ASTM C 230, five drops in 30 seconds.)
   b. Fluid working time of at least 15 minutes.
   c. Flowable for at least 30 minutes.

3. The grout when tested shall not bleed at maximum allowed water.

4. The non-shrink property is not based on a chemically generated gas or gypsum expansion.

5. Product and Manufacturer: Provide one of the following:
   a. Set Grout, as manufactured by Master Builders, Inc.
   b. NBEC Grout, as manufactured by Five Star Products, Inc.
   c. NS Grout, as manufactured by the Euclid Chemical Company.
   d. Or equal.

2.2 CURING MATERIALS

A. Curing materials shall be as specified in Section 03305, 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.

2.4 NSF Approval

A. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section, shall require NSF/ANSI 61, Drinking Water System Components and Health Effects, approval or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.
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 03305, Concrete.
   4. Grout shall be cured following manufacturer’s instructions for prepackaged grout and the requirements in Section 03305, Concrete.

B. Columns, Beams and Equipment Bases:
   1. 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.

++ 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 repair or rehabilitate all existing concrete members and surfaces identified in the Contract Documents.
2. Repair all damage to new and existing concrete construction as specified herein, except that where such repairs are specified in Section 03305, 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 C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
6. ASTM D 903, Test Method for Peel or Stripping Strength of Adhesive Bonds.
7. ASTM D 4258, Standard Practice for Surface Cleaning Concrete for Coating.
8. ASTM D 4259, Standard Practice for Abrading Concrete.
10. SP 13/NACE No. 6, Surface Preparation of Concrete.
11. NSF/ANSI 61, Drinking Water System Components Health Effects.

B. Construction Tolerances: Construction tolerances shall be as specified in Section 03305, Concrete, except as specified herein and elsewhere in the Contract Documents.

C. Qualifications:
   1. Applicator of concrete repair products and epoxy coatings must be approved, in writing, by manufacturer.
   2. Manufacturer of concrete repair products and epoxy coatings shall have a minimum of ten (10) years experience in manufacturing concrete repair products and epoxy coatings with documented performance history for similar installations.
   3. Applicator/installer of concrete repair products and epoxy coatings shall have a minimum of three (3) years experience installing similar products and coatings and shall be licensed or approved in writing by manufacturer to apply/install the products.

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.

B. Certifications:
   1. 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.
   2. Certificate of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-4-119, in accordance with Section 01600 requirements.
   3. Certification/approval of applicator/installer of concrete repair products and epoxy coatings per Paragraph 1.2.C.

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 ANTI-CORROSION BONDING AGENT

A. Anti-corrosion bonding agent shall be a three-component, epoxy modified, cementitious product specifically formulated as a bonding agent and an anti-corrosion coating. Anti-corrosion bonding agent shall bond to steel and concrete and provide corrosion resistance for reinforcement in concrete restoration.

B. Product and Manufacturer: Provide one of the following:
   1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
   2. Duralprep A.C., as manufactured by Euclid Chemical Corporation.
   3. Or equal.

2.2 CEMENTITIOUS POLYMER MODIFIED PATCH

A. Cementitious polymer modified patch shall be a two component polymer modified Portland cement non-sag mortar for patching vertical and overhead concrete surfaces.
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 123 Plus, as manufactured by Sika Corporation.
   2. Verticoat, as manufactured by Euclid Chemical Corporation.
   3. Or equal.

2.3 CEMENTITIOUS POLYMER MODIFIED FINISHING MORTAR

A. Product and Manufacturer: Provide one of the following:
   1. SikaTop 121 Plus, as manufactured by Sika Corporation.
   2. Tammscrete, as manufactured by Euclid Chemical Corporation.
   3. Or equal.

2.4 EPOXY BONDING ADHESIVE

A. Epoxy bonding adhesive shall be a two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardended concrete.

B. Product and Manufacturer: Provide one of the following:
   1. Sikadur 32, Hi-Mod LPL, as manufactured by Sika Corporation.
   2. Euco No. 452 MV, as manufactured by Euclid Chemical Corporation.
   3. Or equal.

2.5 ELASTOMERIC SEALANT/ADHESIVE

A. Elastomeric sealant/adhesive shall be a one-component, polyurethane-based elastomeric sealant specifically formulated to seal all types of joints up to a maximum depth of 1/2 IN.

B. Product and Manufacturer: Provide one of the following:
   1. Sikaflex 1a, as manufactured by Sika Corporation.
   2. Or equal.

2.6 EPOXY COATING

A. Epoxy coating shall be a pigmented, two-component, epoxy resin specifically formulated to serve as a protective, corrosion-resistant coating to all common structural substrates. Epoxy coating shall have the following properties:

B. Product and Manufacturer: Provide one of the following:
   1. Sikagard 62, as manufactured by Sika Corporation.
   2. Or equal.
2.7 NSF APPROVAL

A. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this Section, shall require NSF/ANSI 61, Drinking Water System Components Health Effects, approval or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION

3.1 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 be cleaned in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
   2. Abrasive blast or hydro blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove all laitance, foreign material, and unsound concrete.
   3. 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.
   4. 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.
   5. 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 repaired.

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 03305, 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, unrepaired 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.
      a. All corrosion shall be removed from exposed reinforcing bars by abrasive blasting to a white-metal finish.
   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:
   1. Coat the extent of the chipped concrete within the repair area and any exposed reinforcing bars or embeds with a minimum of two coats of 20 mils each (40 mils thickness total) of anti-corrosion bonding agent/reinforcement protection in accordance with the manufacturer’s recommendations.
   2. Patch repair area with cementitious polymer modified patch material in accordance with manufacturer’s recommendations and the additional requirements of this section.
   3. Apply a seal coat of epoxy bonding adhesive over the patch, extending it one inch beyond the patch on all sides.
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 a 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 a 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 03305, Concrete, 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 cementitious polymer modified patch 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. Cementitious Polymer Modified Patch Placement:
1. The procedures recommended by the manufacturer for the mixing and placement of the cementitious polymer modified patch shall be followed.
2. After the initial mixing of the cementitious polymer modified patch, additional water shall not be added to change the consistency should the mix begin to stiffen.
3. Cementitious polymer modified patch 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 cementitious polymer modified patch so as to create locally raised areas. Where there is a transition with wall surfaces which are not in need of repair, the cementitious polymer modified patch shall not be feathered at the transition. A score line shall be sawcut to not less than the minimum cementitious polymer modified patch 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 cementitious polymer modified patch 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 cementitious polymer modified patch surface does not exceed 0.125-inch and the gap between a 48-inch straight edge and the cementitious polymer
modified patch surface does not exceed 0.25-inch. This shall apply to straight edges placed in any orientation at any location.

D. Finishing:
1. The cementitious polymer modified patch 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 cementitious polymer modified patch fillet.

E. Curing:
1. Curing shall be performed as recommended by the cementitious polymer modified patch 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 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 cementitious polymer modified patch:
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 C 109. 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. CONTRACTOR shall make allowance for a Technical Service Representative to give on-site demonstrations regarding proper preparation and application for each product used for concrete repair and rehabilitation prior to any construction on the Project. Any costs incurred for such services shall be incidental to the cost of the repair work.

D. Repair Concrete: Repair concrete shall be tested as required in Section 03305, Concrete.

++ END OF SECTION ++
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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 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:
   2. ASTM A 36, Specification for Carbon Structural Steel.
   6. ASTM A 325, Specification for High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
   8. AWS D1.1, Structural Welding Code.
11. AISC, Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings and including the Commentary and Supplements thereto as issued.
12. AISC, Specifications for Structural Joints using ASTM A 325 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. Prepare shop drawings under NISD Quality Procedures Program
         certification.
      b. 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.
      c. 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, in ample time to not delay that Work.
   2. Comply with the requirements of Section 03252, Anchorage in Concrete.

B. Store materials to permit easy access for inspection and identification. Keep steel
   members off the ground, using pallets, platforms, or other supports. Protect steel
   members and packaged materials from corrosion and deterioration.
   1. Do not store materials on the structure in a manner that might cause
      distortion or damage to the members or the supporting structures. Repair or
      replace damaged materials or structures as directed.
   2. Comply with the requirements of Section 01661, Storage of Materials and
      Equipment.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
   1. All W-shapes and WT-shapes: ASTM A 992.
   2. All other plates, bars, and rolled shapes: ASTM A 36.

B. Headed Stud Type Shear Connectors: ASTM A 108, Grades 1010-1020, with
dimensions complying with AISC Specifications, or equal.

C. 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 A 325.
   2. All high-strength fasteners, nuts, and washers to be galvanized, unless noted
      otherwise on Drawings.

D. Electrodes for Welding: E70XX complying with AWS D1.1, Design of New
Buildings, Section 8. AWS D1.1.

E. Surface Preparation and Shop Priming: All structural steel shall be hot-dip
galvanized per ASTM A123 with minimum coating of 2.0 OZ of zinc per square
foot of metal (average of specimens) unless noted otherwise or dictated by
aforementioned standards. Surface preparation is specified in Section 09900,
Painting.

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 A 325 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.
   a. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

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.

D. Holes and Appurtenances for Other Work:
   1. Provide holes required for securing other work to structural steel framing, and for the passage of other work through steel framing members, as shown on the Shop Drawings. If large block-outs are required and approved by the
Engineer, the webs shall be reinforced to develop specified shears. Provide threaded nuts welded to framing, and other specialty items as shown on the Drawings to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

3. Refer to Paragraph 1.1.B, above, for the requirements of coordination with others.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which structural steel Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 ERECTION

A. General: Comply with the AISC Specifications and Code of Standard Practice, and as herein specified.

B. Surveys: Provide services of a registered surveyor to check lines and elevations of concrete bearing surfaces, and locations of anchor bolts and similar devices before steel erection proceeds. Discrepancies shall be reported immediately to ENGINEER, in writing. Do not proceed with erection until corrections have been made, or until compensating adjustments to the structural steel Work have been agreed upon with ENGINEER.

C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.

D. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with OSHA requirement of a tightly planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which Work is performed.

E. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place Work.

1. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.
a. Refer to Section 03252, Anchorage in Concrete, of these Specifications for anchor bolt installation requirements.

F. Setting Bases and Bearing Plates: Clean concrete 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.

G. Field Assembly: Set structural frames accurately to the lines and elevations as shown on the Drawings. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces, which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of the structure within tolerances as specified in AISC Manual. For members requiring accurate alignment, clip angles, lintels and other members shall be provided with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
2. Splice members only where shown on the Drawings or specified.

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

I. Comply with AISC Manual for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
1. Do not enlarge unfair holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

J. Gas Cutting: Do not use gas cutting torches for correcting fabrication errors in the structural framing. Cutting will be permitted only on secondary members, which are not under stress, as acceptable to ENGINEER. Finish gas-cut sections equal to a sheared appearance when permitted.

K. Touch-Up Painting:
1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 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. Inspect shop and field welding in accordance with AWS D1.1, Section 6 with the additional requirements identified in Paragraph 1.2.D.
   2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
   3. Inspect structural steel which has been erected.
   4. 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.
   5. 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.
   6. 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 ++
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. Ladders.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and
   recommendations of the following, except as otherwise shown and specified:
   1. ASTM A 36, Specification for Carbon Structural Steel.
   2. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped,
      Zinc-Coated, Welded and Seamless.
   3. ASTM A 123, Standard Specification for Zinc (Hot-Dip Galvanized)
      Coatings on Iron and Steel Products.
   4. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel
      Hardware.
   5. ANSI A14.3, Safety Requirements for Fixed Ladders.
   6. AWS D1.1, Structural Welding Code.
   7. NAAMM, Metal Finishes Manual.
   8. 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. Certification that manufactured units meet all design loads specified.
   2. Fabrication and erection details of all assemblies of miscellaneous metal Work sealed and signed by a Professional Engineer registered in the State of Arizona. 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.
   3. Structural design calculations:
      a. Indicate all required design loads.
      b. Sealed and signed by a Professional Engineer registered in the State of Arizona.
         1. Calculations to be for information only.
         2. Engineer’s review not required.
   4. Copies of manufacturer’s specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
   5. Refer to and comply with the requirements of Section 01330, Submittals and Section 16050, General Provisions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Pipe: ASTM A 53.

B. All other Steel Plates, Shapes and Bars: ASTM A 36.
C. Zinc Coated Hardware: ASTM A 153.

D. Surface Preparation and Hot-Dip Galvanizing: Refer to Section 09900, Painting. All steel shall be hot-dip galvanized, as noted herein. Surface preparation and hot-dip galvanizing requirements are included herein, but are specified in Section 09900.

2.2 MISCELLANEOUS METAL ITEMS

A. 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 1-1/2 inch nominal diameter Schedule 80 round pipe side rails, spaced 18-inches apart, minimum.
      b. Provide extruded square rungs, spaced 12-inches on centers, maximum, with integral non-slip surface on all sides of each rung. Adhesive strips for non-slip surfaces will not be allowed.
   2. Fit rungs in centerline of side rails. Rungs shall penetrate inside wall of side rails and shall have full penetration weld all around rung. Do not extend rungs beyond the outside face of the side rail.
   3. Support each ladder at top and bottom and at intermediate points spaced not more than four 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 steel conforming to ASTM A 53 for side rails and ASTM A 36 for rungs.
   5. Hot-dip galvanize ladder after fabrication per ASTM A 123/ASTM A 153 with a minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

D. 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.

E. Fasteners and Fittings: Provide zinc coated hardware for all galvanized fabrications, unless otherwise shown on the Drawings or specified.

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.

++ END OF SECTION ++
SECTION 05521

STEEL HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified or required to furnish steel handrail and railing systems.
2. The extent of the Work is shown on the Drawings and includes the following types:
   a. Stainless steel pipe and tube handrails and railings.
3. Provide openings in and attachments to railings to accommodate the Work under this and other Sections. Provide all items for the railings such as anchor bolts, fasteners, 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 railings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown on the Drawings or specified.
2. ASTM A 554, Specification for Welded Stainless Steel Mechanical Tubing.
4. AWS D1.1, Structural Welding Code (Steel).
5. AWS D1.6, Structural Welding Code (Stainless Steel).
6. NAAMM, Metal Finishes Manual.
7. ANSI A12.1, Safety Requirements for Floor and Wall Openings, Railings, and Toe boards.
8. OSHA Part 1910.23, Guarding Floor and Wall Openings and Holes.
10. NSF/ANSI 61, Drinking Water System Components Health Effects.
B. Manufacturer of railing system shall guarantee, in writing, the availability of replacement parts and components for a period of not less than five years after completion of the Work.

C. Codes:
   1. Comply with the applicable requirements of OSHA and the 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. Qualifications for Welding Work:
   1. Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code - Steel" D1.1, Section 5, Qualification and "Structural Welding Code – Stainless Steel” D1.6, Section 4, Qualification, as applicable.
   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. Drawings for the fabrication and erection of handrail and railing systems with sizes of members, components and anchorage devices, all based on specified requirements. Include copies of manufacturer's specifications, standard and custom detail drawings and installation instructions for handrail and railing systems. Include all plans and elevations identifying the location of all handrail and railing systems, and details of sections and connections. Show all anchorage items.
   2. Profiles of handrail and railing systems components, and the details of forming, jointing, sections, connection, internal supports, trim, and accessories. Provide details drawn at 1-1/2-inch scale.
   3. All calculations for complete structural analysis of the handrail and railing systems including calculations showing compliance with system performance criteria specified. The calculations shall be prepared, signed and sealed by a Registered Professional Engineer licensed in the State of Arizona.
4. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by ENGINEER.

5. Certificate of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-4-119 in accordance with Section 01600 requirements.

B. Certification: Furnish certification by manufacturer that loading tests have been performed on the handrail, and that it conforms to all applicable OSHA and ANSI requirements for load and deflection.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Stainless Steel Railings:
   1. Protect handrails and railings by paper or an approved coating, against scratching, nicks, gouges, dents, splashes of mortar, paint or other defacements during transportation and erection. Protect until completion of adjacent work specified under other Sections of these Specifications.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Maintain the visual design concept shown on the Drawings, and the technical requirements specified, including modules, profiles, alignment of components and requirements for finish.
   2. Provide handrail and railing systems that conform to the Phoenix Building Code and OSHA, Part 1910.23, including the 200 pound loading requirement. In addition, the system shall conform to the following requirements:
      a. Completed railing and handrail systems shall withstand a uniform lateral force of 40 pounds per linear foot and a vertical uniform force of 50 pounds per linear foot, both applied simultaneously at the top of the handrail and railing.
      b. Intermediate and bottom rails shall withstand simultaneously applied lateral uniform forces of 40 pounds per linear foot and a vertical load of 50 pounds per linear foot, however, lateral and vertical loads on intermediate and bottom railings need not be considered in the detailing and fabrication of posts and anchorages.
      c. For railings having panels, the panels shall be detailed and fabricated to withstand a uniform lateral load of twenty pounds per square foot.
      d. Concentrated 200 pound load and uniform force conditions shall not be applied simultaneously.
e. Other pertinent requirements ceded to ICC ANSI 117.1, Accessible Building and Facilities, by the Phoenix Building Code.

f. Bending stresses shall not exceed 60 percent of the yield stress of the material. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.

g. Select schedule of pipe, minimum diameter, loadings and maximum post spacing specified in order to limit deflection in each single-span of railing and handrail to 1.5-inches maximum and on railing posts to 1.4-inches maximum and with a safety factor of 1.65:1 for all Work.

3. Thermal Control: Provide adequate expansion within fabricated systems that allows for a thermal expansion and contraction caused by a material temperature change of 140°F to -20°F without warp or bow of system components. Distance between expansion joints shall be based on providing a 1/4-inch wide joint at 70°F, which accommodates a movement of 150 percent of the calculated amount of movement for the specified temperature range.

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

5. Provide handrail and railing systems as shown on the Drawings. Where handrail or railing systems are required by either the governing authority or the Occupational Safety and Health Act of 1970, or the Americans with Disabilities Act of 1990, aluminum handrail and railing systems of the type specified herein shall be provided.

6. Configuration of all handrail and railing systems components shall be as shown on the Drawings. Verify dimensions at the site without causing delay in the Work.

7. Except where detailed dimensions are shown on the Drawings, indicate required locations for posts, space posts maximum (6 FT) on centers.

8. Where details show post location requirements at or near end of runs, uniformly space intermediate posts as required to meet loading and deflection criteria specified, but not greater than maximum spacing specified. Where posts are shown on the Drawings at straight walkways and other locations where railing is provided on each side, locate railing system posts opposite each other; do not stagger.

9. Comply with custom fabricated handrail and railing systems details shown on the Drawings. Provide fabricator's standard details for conditions not shown on the Drawings and for general system assembly, unless otherwise specified. All details shown on the Drawings are typical; similar details apply to similar conditions, unless specifically otherwise shown on the Drawings.

10. Fabricator is responsible for structural analysis and detailing of handrails and railings systems. Provide complete structural calculations and verification of other system performance criteria and Shop Drawings for all handrail and railing members, anchors and all other support system components prepared, signed and stamped with the seal of a Licensed Professional Engineer licensed to practice in the State of Arizona and recognized as an expert in the specialty involved.
2.2 MATERIALS

A. Stainless Steel Castings: ASTM A 743, Grade CF8.

B. Stainless Steel Tube: ASTM A 554, Grade MT 316; 1.90-inches OD with 0.065-inch wall thickness.

C. Stainless Steel Bars and Shapes: ASTM A 276, Grade 316.

D. Stainless Steel Pipe Handrails and Railings:
   1. Welded:
      a. Use a stainless steel, welded pipe railing system with posts, top and intermediate rails, and welded joints.
      b. Product and Manufacturer: Provide one of the following:
         1) Resist-O-Rail Stainless Steel Railing, as manufactured by Tubular Products, Incorporated.
         2) Or equal.

D. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this section shall require NSF/ANSI 61, Drinking Water System Components Health Effects, approval or comply with Arizona Administrative Code R18-4-119, Standards for Additives, Materials, and Equipment.

2.3 FABRICATION

A. General: Form exposed Work true to line and level with accurate angles and surfaces and straight sharp edges. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.

B. Fabricate to profiles shown on the Drawings.

C. Connections:
   1. Welded Connections: Cope intersections of rails and posts, weld joints and grind smooth. Butt weld end-to-end joints of railings or use welding connectors.
      a. Weld corners and seams continuously and as follows:
         1) Stainless Railings: Fusion welding process utilizing the inert gas method with a non-consumable tungsten electrode.
         b. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces.
         c. Welding of stainless steel shall comply with the requirements of AWS D1.6.
D. Post Reinforcement: Stainless steel tube posts may be reinforced with galvanized pipe, if required to meet OSHA and ANSI loading requirements.  
   1. Welding of galvanized steel shall comply with the requirements of AWS D1.1.

E. Toe boards: Provide toe boards of same material as railings on railings around openings, platforms, and balconies. Fabricate to the dimensions and details shown on the Drawings. Securely fasten toe board in place with not more than 1/4-inch clearance above floor level. Toe boards shall meet requirements of OSHA Part 1910.23, Section (e).

F. Brackets, Flanges, and Anchors: Provide brackets, flanges, and anchors for railing posts and for handrail supports. Furnish inserts and sleeves as required for anchorage to concrete or masonry. Components shall be in accordance with manufacturer's recommendations.

G. Finish:  
   1. Stainless Steel Railings: Provide No. 4 polished finish, minimum, unless otherwise shown on the Drawings or specified. Finish as specified in the NAAMM "Metal Finishes Manual".

PART 3 - EXECUTION

3.1 ASSEMBLY OF PROPRIETARY RAILING SYSTEMS

A. Assemble systems in strict accordance with manufacturer's recommendations for installation and as shown on the Drawings.

3.2 INSTALLATION

A. Fastening to In-Place Construction:  
   1. Provide anchorage devices and fasteners where necessary for securing handrails and railing items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors, as required. Use devices and fasteners that are compatible with installed material.

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. Field welding will not be permitted, unless approved by ENGINEER. Do not
cut or abrade the surfaces of units which have been coated or finished after fabrication, and are intended for field connections.

3. Permanent splice connections shall be made in accordance with manufacturer's instructions.

4. Provide approved slip connections in top and bottom rails at each expansion joint.

5. Space posts on centers, (6) feet maximum, unless otherwise shown on the Drawings.

6. Adjust railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
   a. Anchor posts in concrete by means of sleeves set and anchored into the concrete floor slab. Provide closure secured to the bottom of the sleeve. Unless otherwise shown, after the posts have been inserted into the sleeves, fill the annular space between posts and sleeves solid with grout as specified in Section 03305, Concrete. Crown grout around posts so that drainage will be away from posts.
   b. CONTRACTOR may request, in writing, to install the anchor posts in concrete by core drilling holes. Drill holes not less than 1-inch greater than the outside diameter of post. Reinforcing steel shall not be cut by the core drilling. Fill the annular space with grout as specified above.
      1) Submit the formal request to the ENGINEER for approval. Prior to the approval of the core drilling request, submit Shop Drawings that indicate any field adjustments that must be completed prior to the core drilling.
   c. Anchor posts to steel with stringer or support flanges, angle type or floor type as required by conditions, shop connected to posts and bolted to the steel supporting members.
   d. Side mount posts by fastening them securely in brackets attached to steel or concrete fascia as shown on the Drawings, and in complete accordance with manufacturer’s instructions.

7. Secure handrails to walls with wall brackets and end fittings as shown on the Drawings. Drill wall plate portion of the bracket to receive one bolt, unless otherwise shown on the Drawings for concealed anchorage. Locate brackets as shown on the Drawings or, if not shown on the Drawings, at not more than (6) feet on centers. Provide flush-type wall return fittings with the same projection as that shown for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:
   a. For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

3.3 REPAIR
A. Stainless Steel Railings: Remove protective materials in accordance with manufacturer's instructions. Make surfaces clean and free from stains, marks or defects of any kind.

B. Remove stained or otherwise defective Work and replace with material that complies with the requirements of the Specifications.

++ END OF SECTION ++
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PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install standing seam metal roofing as shown on the Drawings and specified. The Work also includes:
      a. Providing openings in standing seam metal roofing to accommodate the Work under this and other Sections and building into the standing seam metal roofing all items such as sleeves, inserts and all other items to be embedded in standing seam metal roofing for which placement is not specifically provided under other Sections.
   2. The extent of standing seam metal roofing Work is shown on the Drawings, and is defined to include exterior standing seam metal roofing, cap and drip flashings, metal closures and all other associated trim and accessories.
   3. The types of standing seam metal roofing Work required includes, but is not limited to, the following:
      a. Structural standing seam metal roofing panels.
      b. Sliding clips and fasteners to attach standing seam roof panels to the roof structure.
      c. All flashing and miscellaneous trim required for complete water-tight system including reglets, flashing, counterflashing, and sealants.
      d. Curbs, walkways, and associated accessories.
      e. Metal fascia system.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or embedded in, the standing seam roof panels.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide company specializing in structural standing seam metal roofing with a minimum of ten years of experience.
   1. All structural components of the roof system shall be designed and sealed by a Registered Professional Structural Engineer licensed in the State of Arizona.
   2. All roll forming performed on-site shall be supervised by personnel trained and employed by the standing seam metal roofing manufacturer. Roofing
manufacturer shall have been engaged in field roll forming for a minimum of 15 years with experience in roll forming long panels that are similar in length to those being used on this Project.

3. All installation of all fastening and metal roof components shall be supervised and inspected by personnel trained and certified by the standing seam metal roofing manufacturer.

B. Contractor and Installer Qualifications:
   1. Engage a single installer regularly engaged in standing seam metal roofing installation and with experience in the erection of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
   2. Installing contractor shall be trained and certified in writing by the standing seam metal roofing manufacturer.
   3. Contractor and installer shall have a minimum of seven years experience in the installation of structural standing seam metal roof systems similar to the system being specified for this Project.
   4. Contractor and installer shall have successfully completed two projects of similar size, scope, and complexity within the past three years.

C. Requirements of Regulatory Agencies:
   1. Comply with UL Construction No. 95 for Class 1-90 wind uplift rating.

D. Design Criteria:
   1. Provide standing seam roofing panels, framing and accessories that comply with the following minimum performance characteristics:
      a. Wind loading shall be 120 miles per hour, unless heavier loading is required by the Phoenix Building Code.
   2. Anchorage system shall be designed so that panels are free to move for expansion and contraction and so that individual panels may be removed without disturbing adjacent panels.
   3. Form panels in lengths as required.

E. Source Quality Control: Obtain all standing seam metal roofing panels and accessories from the same manufacturer.

F. Mock-Ups:
   1. Prior to start of permanent roof construction, construct mock-ups of roofing system to be used on Project. Mock-ups shall be a minimum five feet by five feet in size and be of sufficient size to properly display all components required by the roofing system. Provide multiple mock-ups as required.
   2. Mock-ups shall incorporate all components specified and/or required for a complete water-tight roof system. Components shall include, but no be
limited to, the following: roofing panels including mounting system and seaming, all fascia conditions, all flashing and counterflashing conditions (including eave, rake, hip, and ridge conditions, roof/vertical wall intersections, roof penetrations, and all reglet conditions), all miscellaneous clips, angles, plates, brackets, closures, and sealants.

3. Panels and components shall be the same as specified or approved for the Project. Exact color is not necessary, however, Contractor is to label each exposed component to identify final installed color of component.

4. Step construction of mock-ups to allow observation of all components.

5. Construct additional mock-ups or re-work existing mock-ups until acceptable to Engineer and Owner.

6. Maintain mock-ups at project site until Engineer and Owner approves of removal of mock-ups.

7. Approved mock-ups to constitute minimum acceptable standard of quality for actual construction.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:

1. American Architectural Manufacturers Association (AAMA), 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.


4. ASTM A 653, Specification for Steel Sheet, Zinc-Coated, (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.


22. UL, Building Materials Directory.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Samples of each type of standing seam metal roofing panel and trim complete with factory-applied finish, two foot long by full-width. Samples will be reviewed by ENGINEER for pattern, texture and color only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.
   2. One of each type fastener employed, with statement of intended use. Samples will be reviewed by ENGINEER for material and color only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.
   3. Complete selection of manufacturer's standard and custom colors.
   4. 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, standard and custom detail drawings and installation instructions for standing seam metal roofing panels, supports and trim. Submit manufacturer's standard warranty on factory-applied finish of preformed metal roofing panel.
   2. Profiles of standing seam roofing panel units, and the details of forming, jointing, gaskets (if any), supports, anchorages, trim, flashing, and accessories. Show details of weatherproofing at edges, terminations and penetrations of the standing seam roof panel Work. Show 1/4-inch to the foot scale layout and elevations of entire Work. Show all details at 3-inch to
the foot scale, indicating all internal components and intersection members, details and special fabrication techniques.

3. Complete selection of manufacturer's standard and custom colors.

C. Submit design computations signed and sealed by a Registered Professional Structural Engineer licensed in the State of Arizona certifying that the system structural components meet the requirements for lateral, upward and downward loads specified and thermal movement allowance of the panel system, for review with Shop Drawings.

D. Test Reports: Submit for approval certified laboratory tests reports for required performance tests:
1. Air Infiltration: ASTM E 283.
3. Wind Uplift: UL-90 rated wind up-lift resistance requirement specified in UL 580 test.
5. Weathering: ASTM G 152, ASTM G 153, and ASTM G 155
11. 100,000 cycle clip wear test showing zero wear between the clip and the roof panel.
12. Clip pull-out tests and calculations.
13. ASTM E 1592 test results for panel size, gage, clip type, and spacing similar to panels and clips being used for the Project.
14. Concentrated load test data. Section 2.5 G lists concentrated load test requirements.

E. Certification: Submit for approval written certification prepared, signed and sealed by a Registered Professional Structural Engineer, licensed in the State of Arizona, verifying that the design meets indicated loading requirements and codes of authorities having jurisdiction.
1. Provide written certification to the ENGINEER from the coil manufacturer verifying that the coil to be used for on-site roll forming is compatible with the roll forming machinery that will be used.

F. Qualifications:
1. Manufacturer to submit certifications that qualifications listed in Paragraph 1.2.A are met.
2. Contractor to submit certifications that qualifications listed in Paragraph 1.2.B are met.
3. Installer to provide qualifications of all personnel expected to be working on the Project.

G. Guarantees: Submit for approval manufacturer’s and CONTRACTOR'S written guarantees as specified, herein.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver standing seam metal roofing paneling and all accessories dry and undamaged, with manufacturer's protective coating intact.
2. Deliver standing seam metal roofing panels in bundles with banded wood surrounds and end caps intact.
3. Comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

B. Storage and Handling of Materials:
1. Store standing seam roof paneling and accessory materials in a manner that will protect the panels from exposure to sun and condensation; with good air circulation around each piece.
2. Store standing seam roof paneling and accessory materials in an area protected from dirt, damage and weather.
3. Do not store in contact with concrete or other materials that might cause corrosion.
4. Do not subject standing seam roof paneling and accessory materials to bending or stress.
5. Do not damage edges or handle material in a manner that will cause scratches, warps or dents.
6. Comply with the requirements of Section 01661, Storage of Materials and Equipment.

1.5 GUARANTEE

A. Provide twenty year complete system warranty, including material for weather tightness of entire roof assembly signed by the panel manufacturer and certified erector.
1. Warranty limits shall meet the minimum load capacity requirements of ASTM E1592.

B. Provide manufacturer's standard warranty on the coil coated polyvinylidene fluoride based coating specified, herein.

C. Guarantee that the polyvinylidene fluoride based coating meets all criteria specified and will not spall, check, craze, peel or otherwise lose adhesion for a period of twenty years from the date of Final Acceptance, to the extent that such
shall create unsightly conditions or otherwise impair the intended architectural qualities of the building.

D. In the event that the coil coated polyvinylidene fluoride based coating fails to meet the specified standards the manufacturer shall, at his expense, replace or field paint, at the discretion of the ENGINEER, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.

E. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the manufacturer.

F. Provide written guarantee agreeing to replace standing seam metal roofing panel Work which fails in material or workmanship within one year of the date of Final Acceptance. Failure of materials or workmanship shall include, but is not limited to, deterioration in excess of normal weathering and lack of water or weather tightness. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of the OWNER at the CONTRACTOR’S expense.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Roof, Ridge Cap, Eave Vent, and Fascia Panels:
   1. Fabricate metal panels from a minimum of 0.040 IN thick aluminum alloy 3004-H-14.

B. Miscellaneous Aluminum Components:
   1. Aluminum allow 6001-T6, 32,000 psi minimum tensile yield strength.
   2. ASTM B 209 for sheets and plates.
   3. ASTM B 221 and B 308 for shapes, beams, channels, angles, tees, and zees.
   4. ASTM B 247 for forgings.

C. Flashing and Trim:
   1. Provide flashings and sheet metal contour closure trim components, indicated or required for a complete installation, as part of the preformed metal roofing panels Work, including cap flashings, base and drip flashings, closure and batten cleats, panel stops and closures, surrounds at openings, soffits, and similar components of the Work.
   2. Provide factory fabricated trim components.
   3. Except as otherwise shown on the Drawings or specified, match the material, gage, and finish of the standing seam metal roofing panels.
   4. Provide all concealed fasteners for flashing and trim Work.
D. Fasteners: ASTM F 593, Type 316 stainless steel.

E. Shims: Type 316 stainless steel.

F. Sliding Clips: Type 316 stainless steel.

G. Sealant: See Section 07920.

H. Miscellaneous Materials:
   1. Provide manufacturer's custom, stainless steel, self-tapping concealed fasteners, and hold-down cap assemblies, and other components needed for a complete, permanently weatherproof installation. Provide stainless steel complying with ASTM A 167.
   2. All fasteners used at all locations shall be stainless steel.
   3. Sealant: Provide manufacturer's standard factory applied elastomeric sealant for use within this Section of the Work, where applicable.

I. Provide strippable film of liquid applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed before installation.

J. Product and Manufacturer: Provide one of the following:
   1. Bemo USA Corporation – Bemo-Roof Mechanically Seamed Roofing System.
   2. Or equal. Other manufacturers capable of providing the specified structural standing seam system and profiles conforming to the design intent of that specified will be considered upon submission of test data and samples 14 days prior to the bid. Written approval must be obtained prior to bidding.

2.2 FABRICATION

A. General:
   1. Comply with the dimensions, profile limitations, gages and fabrication details shown on the Drawings or specified.
   2. Fabricate with square, true corners, mitered and welded.
   3. Prefabricate all components of the system at the factory, ready for field assembly of standing seam roofing panels, joint cleat, sliding clips, trim and accessories.
   4. Fabricate components and assemble units to comply with the performance requirements specified for the completed installation of the Work.
   5. Fabricate panels in full length with no end laps. Any roll-forming of panels at the jobsite must be performed with industrial type rolling mill having at least 10 stands to gradually shape the sheet metal, maintaining flatness and strict tolerances.
B. Standing Seam Metal Roof Panels:
   1. Height of standing seam: 2-1/2 IN minimum.
   2. Minimum thickness: 0.040 IN.
   3. Width: 16 IN. Provide longitudinal stiffening elements to minimize oil
canning.
   4. System shall be designed as a true structural standing seam shape.
   5. Finish: See Paragraph 2.3 below.
   6. Provide concealed fasteners in all locations. If exposed fasteners are required
by the roof manufacturer, because of location, constructability issues or other
critical design requirements, then finish of fastener shall match roof panel
finish. Exposed fasteners are to be approved by Engineer. The use of
deflection limiter devices is not allowed.

C. Intermediate Support System:
   1. Roof panel sliding clips shall be the manufacturer’s standard two-piece
sliding clip suitable for Project conditions. Sliding clips shall allow a
minimum of 3 IN of total movement parallel to the seams of the roof panels
for thermal expansion and contraction of the panels. Sliding clips shall hold
the roof panels at least 1/2 IN off of the roof structure and provide a bearing
surface for the roof panels to prevent the panels from contacting the roof
structure. Sliding clips shall be provided in minimum 18 GA Type 316
Stainless Steel.
   2. Roof panel fixing clips shall be the manufacturer’s standard one-piece clip
suitable for the Project conditions. Two-piece clips are acceptable, if required
by the roofing manufacturer. Fixing clips shall not allow any movement
parallel to the seams of the roof panels from thermal expansion and
contraction. Fixing clips shall hold the roof panels at least 1/2 IN off of the
roof structure and provide a bearing surface for the roof panels to prevent the
panels from contacting the roof structure. Fixing clips shall be provided in
minimum 18 GA Type 316 Stainless Steel.
   3. Roof panel manufacturer shall be responsible for designing and providing all
necessary intermediate supports, as required, to transfer roof panel loads into
the roof framing members.

2.3 STANDING SEAM METAL ROOF PANEL COATINGS

A. Finish Coating: Apply full strength polyvinylidene fluoride (PVDF) based
coatings on the exterior side of the standing seam metal roofing panels at the
factory by coil coating, prior to fabrication of the standing seam metal roofing
panels. Comply 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 metal panel surface using
phosphates or chromates followed by a cold water rinse. Seal with a chromic
acid rinse and dry, except where panel 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 0.25 to 0.35 mils.

4. Apply finish coating over the primer by roller coating and fuse at a peak metal temperature of 470°F for a dry film thickness of 0.7 to 0.9 mils so that the total dry film is approximately 0.95 to 1.25 mil thick.

5. Color shall be selected by ENGINEER. Color shall be selected from the manufacturer’s full range of primary and secondary colors, excluding exotic, metallic flake, or iridescent colors.

6. Apply a 0.2 mil EPA flexableized epoxy clear coat on the interior side of the panels.

7. Meet or exceed the requirements of AAMA 621.

8. Smooth finish.

B. Product and Manufacturer of PVDF: Provide one of the following:

1. Kynar 500 Fluropon by DeSoto Incorporated.
2. Kynar 500 Duranar by PPG Industries.
3. Or equal.

2.4 ACCESSORIES

A. Ridge Vent and Eave Vent:

2. Minimum 0.040 IN thick.
3. Provide #16 type 316 stainless steel mesh insect screen on hood vents and on lower edge of continuous eaves. Screen edges shall be protected by ¾” (minimum) SST U-Edging frame by McNichols or equal. The frame will allow easy replacement of screen without damage to vent, or screen. Provide electrical isolation between dissimilar metals.
4. Finish and color to match roof panels.

B. Roof Penetration Flashing:

1. Round penetrations: Premolded EPDM with metal collar. Buildex “DEKTITE” or equal.

C. Fall Restraint System:

1. Horizontal lifeline-type fall restraint system as indicated on the Drawings shall meet the requirements of OSHA Standard Number 1926.502.

D. Roof Walkways:

1. Salvage and re-use existing walkways to the extent possible, as shown on the Drawings.
2. New walkways minimum 1-1/2 IN deep aluminum or galvanized plank or grating with non-slip finish to match existing walkways.
3. Grating or plank sections to be 36 IN wide in lengths as necessary for a complete, secure system.
4. All fasteners, plates, washers, clips, brackets, and other hardware required for a complete installation shall be Type 316 stainless steel.
5. Band all edges of grating with 1/8 IN thick aluminum or galvanized steel banding welded at all contact points.
6. Any penetrations through walkways shall be approved by the Engineer.

E. Flashing Curb:
1. Provided by standing seam metal roofing manufacturer.
2. One-piece completely seal welded prefabricated roof curb, including vertical flashing, and counter flashing, cricket on high side of penetration and flat pan fabricated to replace standing seam metal roof panel.
3. Size as required for penetration.
4. Bottom sloped to match roof. Top shall be level.
5. Material and finish to match roof panel.

F. Foam and metal closures, caulking, gaskets, fasteners, washers, sliding clips, angles, and all miscellaneous trims shall be provided by the standing seam metal roofing manufacturer, fabricated for the specific condition required.

2.5 SOURCE QUALITY CONTROL

A. Roof assembly to be Class A roof covering assembly per UL 1256 or FM 4450.

B. The roof system shall be designed to safely resist the positive and negative wind loads as specified below. The areas are as defined by ASCE 7.
1. Main Roof Area: Positive Downward Pressure = 25 PSF, Negative Upward Pressure = 25 PSF.
2. Ridge, Eave, Gable Area: Positive Downward Pressure = 25 PSF, Negative Upward Pressure = 41 PSF.
3. Corner Areas: Positive Downward Pressure = 25 PSF, Negative Upward Pressure = 94 PSF.

C. Structural, uniform uplift load capacity of the panel system shall be determined in accordance with ASTM E 1592.
1. The factor of safety on the test results shall be 1.65 for the panel, batten, or clip ultimate loads with no increase for wind.
2. The factor of safety of fasteners shall be 3.00 for a single fastener per clip and 2.25 for two fasteners per clip.
3. Design uplift capacity for conditions of gage, span, or loading other than those tested may be determined by interpolation of test results. Extrapolation of conditions outside of the range of tests is not acceptable.
4. Deflection shall be L/180 for positive loading.

D. Water Penetration: No uncontrollable leakage at minimum 20 PSF for 15 minutes when tested in accordance with ASTM E 331.

E. Air Infiltration: Maximum 0.02 cfm/SF when tested at 20 PSF differential pressure when tested in accordance with ASTM E 283.

F. Fire Resistance/Wind Uplift Rating.
   1. UL 790, Class 1.
   2. UL 580, Class 90.

G. The panels shall withstand a 250 LB concentrated load applied to a 4 SQ IN area at the center of the panel at mid-span between supports with no panel deformation, rib buckling, or panel sidelap separation which will adversely affect the weather-tightness of the system.

H. Support roofing panels on top of structural frame or connect to manufacturer provided intermediate support system.
   1. Provide attachment to roof structural frame or deck as required for loading criteria specified.
   2. Roof panel anchor clips shall be designed to allow thermal movement of the panels except where specific fixed points are indicated. Roof panel manufacturer shall be responsible for determining fixed point locations unless otherwise indicated.
   3. Maximum spacing of roof clips shall be determined by the manufacturer.

I. Roof panel manufacturer shall be responsible for designing and installing all necessary expansion joints in the roof system. Where roof expansion joints occur, provide corresponding expansion joints in fascia, soffit, and gutter.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the alignment of the substrate framing before erection of the standing seam metal roofing panel Work begins and notify the ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the standing seam metal roofing panel Work until unsatisfactory conditions have been corrected in a manner acceptable to the OWNER.

3.2 PREPARATION
A. Wherever possible, take field measurements, prior to completion of shop fabrication and finishing of standing seam metal roofing panels. Do not delay job progress. Allow for trimming where final dimensions cannot be established before fabrication.

3.3 INSTALLATION

A. Comply with standing seam metal roofing panel manufacturer's instructions for assembly, installation, erection and seaming of metal roofing panel Work.

B. Standing seam roofing panels shall be installed in one continuous length from ridge to eave.
   1. Hand crimp panel seams at each clip location.
   2. Seam panels and battens together with portable electric seaming machine supplied by the manufacturer.
   3. The manufacturer’s inspector must be present for the first two days of roof panel installation, observing clip placement and panel attachment including proper crimping of the panel seams. The inspector is to review the approved shop drawings with the installer to verify agreement between the manufacturer and the installer. See Paragraph 3.4 for additional requirements.

B. Roof panel clips installed into supporting steel framing members shall be pre-drilled. All filings shall be removed prior to fixing the panel clip using Type 316 stainless steel fasteners.
   1. All clips shall be positioned in the range of movement based on a centered position at 75 degrees Fahrenheit. Adjustments to the position of the clips shall be made to account for thermal movement of the deck from the actual temperature throughout installation.
   2. Pre-installed clips are not allowed.

C. Anchor component parts of standing seam metal roofing panel securely in place providing for necessary thermal and structural movement.

D. Do not exceed fastener spacing recommended by the standing seam metal roofing panel manufacturer.

E. All fasteners must be long enough to penetrate through the structural support a minimum of 1/2-inch.

F. Fasten flashings and accessories 12-inches on center.

G. Do not use exposed fasteners on the exterior panel faces.

H. Drive all fasteners normal to the surface and to a uniform depth.
I. Install sealants for the standing seam metal roofing panel Work as specified, and as required for watertight performance. Comply with sealant manufacturer's instructions for installation and curing.

J. Do not fabricate flashings, closures and associated trim at the site.

K. Install all special flashing and trim shapes, and calking compounds required to maintain complete weathertightness.

L. Comply with roofing panel manufacturer's instructions and recommendations.

3.4 FIELD QUALITY CONTROL

A. Determine conformity of standing seam metal finish to this Section as follows:
   1. The manufacturer of the standing seam metal roofing shall set aside a labeled sample of the standing seam metal roofing panels from each production lot of panels for the job. Protect sample standing seam metal roofing panels from weather.
   2. Make sample standing seam metal roofing panels available at all times, for comparison with installed standing seam metal roofing panel, as requested by the OWNER, for the full time of the warranty.
   4. Manufacturer's technical representative shall visit the site to perform field inspection of the roof panels, flashing and other system components at the start and at Substantial Completion of Work prior to issuance of warranty, as a minimum, and as otherwise requested by the ENGINEER. Each inspection visit shall include a written review of the entire installation to date, signed by the manufacturer's technical representative and submitted to the ENGINEER. Notify the ENGINEER a minimum of two working days prior to the site visit by the manufacturer's technical representative.

3.5 ADJUSTMENT AND CLEANING

A. Set standing seam metal roofing panels plumb, level, and true to line, without warp or rack.

B. Clean exposed surfaces of standing seam metal roofing panel Work promptly after completion of installation. Comply with recommendations of the standing seam metal roofing panel manufacturer.

C. Leave standing seam metal roofing panel and flashing perfectly flat, free from dents, burrs, scratches, holes or other blemishes.
D. Do not erect components which have become scarred, chipped or otherwise damaged or defaced.

E. Remove and replace with new material standing seam metal roofing panels and component parts of the Work, including finish, which have been damaged beyond successful repair, as directed by the ENGINEER. Repair minor damage.

F. Do not use roofing panel sheets, trim members, and flashing sheets, in which holes have been made in locations where fasteners are not required.

G. At the completion of the Work, clean or replace adjacent work, marred by the Work of this Section.

H. Remove all materials and debris and leave the site of the Work in clean condition.

++ END OF SECTION ++
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SECTION 07721

ROOF HATCHES

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 roof hatch Work.
   2. Extent of roof hatches are shown on the Drawings.
   3. Types of products required include the following:
      a. Roof hatch.
      b. Roof hatch safety grate system.
      c. Miscellaneous hardware, closures, fasteners and other accessories.

1.2 QUALITY ASSURANCE

A. Fabrication Criteria:
   1. Roof Hatches: Provide the following:
      a. Fabricate access roof hatches to withstand a live load of 40 pounds per square foot over the horizontal plane of the hatch and a concurrently acting point load of 200 pounds located at the center of the hatches. Specified loadings shall not cause any permanent deflections in the hatch or support curbs or cause damage to operating hardware.

B. Requirements of Regulatory Agencies:
   1. Comply with applicable requirements of the Phoenix Building Code, for roof accessory fabrication and installation and the requirements for resistance to superimposed loadings.
   3. OSHA, Section 1910.27.

C. Source Quality Control: Obtain materials only from manufacturer's who will, if required:
   1. Send a qualified technical representative to the site, for the purpose of advising the installer of proper procedures and precautions during the installation of the items.
   2. Engage manufacturers who has been successfully providing roof accessories of the type specified and who will submit a list of successful installations along with the telephone numbers of owners, architects or engineers responsible for the Work.
D. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:

2. ASTM A 1011, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
5. NAAMM, Metal Finishes Manual.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Copies of manufacturers proposed fabrication details and material specifications for each roof accessory item. Include flashing and roughing-in drawings showing this Work coordinated with the single-ply sheet roofing Work, as appropriate to the location of the item.
2. Provide manufacturer's specifications, installation and coordination instructions and other data as may be requested by ENGINEER substantiating that products comply with the requirements.
3. Maintenance Manuals: Upon completion of the Work, furnish copies of detailed maintenance manuals 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.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:

1. Delivery all materials without damage and in manufacturer's original undamaged protective wrappings bearing name and model numbers of approved items. Refer to and comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

B. Storage and Handling of Materials:
1. Minimize the amount of time roof accessories are stored on site. If roof hatches do arrive on site before they can be incorporated into the orderly assembly of the roofing Work store in completely protected and secure enclosures, under cover and away from all construction traffic.

2. Do not store in contact with earth, wood or concrete or other surfaces which could cause staining or other types of surface marks or blemishes of any kind.

3. Refer to and comply with the requirements of Section 01661, Storage of Materials and Equipment.

4. Do not subject roof hatches to bending or stress of any kind.

5. Handle and protect units during installation in a manner recommended by the roof hatch manufacturer.

1.5 JOB CONDITIONS

A. Scheduling:
   1. Coordinate the installation of roof hatch Work with roofing and flashing Work in order to provide continuity in the installation of roofing Work and to obtain complete and permanently weather-resistant and waterproof construction.
   2. Schedule roof hatch items to arrive at the site as installation of the roofing Work is proceeding such that roof accessory items can be built into the Work as shown on approved Shop Drawings and without the need for field changes to approved installation details or methods of flashing.

B. Protection:
   1. Provide continuous protection of materials against damage primarily by storing materials under cover and above ground and away from other construction traffic.

C. Conform to applicable OSHA and the Phoenix Building Code.

1.6 GUARANTEE

A. Roof Hatches: Provide a written guarantee obtained from the manufacturer of the roof hatches. Guarantee shall state the following:
   1. Roof hatch is to operate properly and be free of defects in material and workmanship for a period of five years from date of Final Completion.
   2. Should any part fail to function, or break in normal use during this period, manufacturer shall furnish and install a new part, at no additional cost to the OWNER.

B. Hatch Fall through Prevention System: Manufacturer's standard 25 year warranty.
PART 2 - PRODUCTS

2.1 PRODUCTS

A. Roof Hatch: Provide the following:
   1. General:
      a. Provide manufacturer's standard units, modified as necessary to comply
         with the requirements of the Specifications. Custom fabricate units
         wherever necessary for size, type and profile, using manufacturer's
         standard detailing to the extent applicable.
      b. Shop fabricate each unit complete with framing, gaskets, structure,
         curbs, flashing, well liner, hardware, accessories, anchorage provisions
         and other components. Disassemble only to the extent required for
         delivery and installation.
      c. Provide manufacturer's recommended operable steel safety posts
         mounted at center of roof ladder rungs.
   2. Materials:
         1) Cover:
            a) Exterior: 11 gauge.
            b) Interior: 18 gauge liner.
            c) Internally reinforced: Minimum 40 psf live loading.
            d) Insulated.
            e) Completely weather sealed and gasketed.
         2) Curb: 11 gauge.
            a) Height: 4 IN minimum.
            b) Integral cap flashing.
            c) Mounting flange: Minimum 3-1/2 IN wide, punched holes for
               fastening to roof deck.
            d) Insulated.
         3) Finish: Mill.
      b. Insulation:
         1) Cover: One inch glass fiber, between panels.
         2) Curb: One inch rigid fiberboard.
      c. Gaskets: Fingered design; polyvinyl chloride.
      d. Hardware: Type 316 stainless steel, unless noted otherwise.
      e. Anchors:
         1) Stainless steel.
         2) See Specification Section 05501.
      f. Fall Protection Grating:
         1) Grating: Aluminum panel(s).
         2) Hardware and hold open device: Type 316 stainless steel.
3) Panel(s) shall be designed to meet the requirements of OSHA standard 29 CFR 1910.23.

4) Panel shall be equipped with a hold open device to lock the grating panel(s) automatically in the open position.

5) Grating panel(s) shall have a provision for locking to prevent unauthorized opening.

6) Finish: Powder coated paint with high visibility safety yellow color.

   g. Manufactured unit shall be with 12 IN high maximum with fully welded corners. Equip units with standard self-lifting mechanism. Provide stainless steel hardware including hold-open devices, vinyl-covered grip handle, hinges, compression spring operators enclosed in telescopic tubes, padlock hasp, latch, and operating handles for inside and outside operation.

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

      1) Bilco Company.
      2) Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

   A. Examine the substrates to receive roof hatches and the conditions under which the roof hatch 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 roof hatch. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

   A. Protection of Aluminum from Dissimilar Materials: Separate metal surfaces of roof hatch from dissimilar metals, and from wood and cementitious substrates. Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09900, Painting.

   B. Bed flanges of set-on accessories in mastic or compound which is compatible with roofing and flashing. On sloping decks, flash flanges with other work for proper water shed.

   C. Anchor roof hatch Work permanently to the substrate, by approved methods which are adequate for the sizes and locations of units and which will develop load-resistance specified.

3.3 CLEANING AND PROTECTION
A. Clean surfaces of roof hatches as required, to prevent deterioration and uneven weathering.

B. Protect roof hatch Work from damage until Final Completion.

++ 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 caulking 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. 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.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   2. ASTM C 661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.

D. 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.

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 C 794 (minimum 5 lbs.): Glass, minimum 21 lbs./linear inch; Aluminum, minimum 18 lbs/ linear inch; Concrete, minimum 21 lbs/linear inch.
         3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
         4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
         5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
      b. Product and Manufacturer: Provide one of the following:
         1) Sonnolastic Two-Part by Sonneborn Building Products, Division of Chemrex, Inc.
         2) Lasto-Meric by Tremco.
         3) Or equal.
B. Exterior and Interior Vertical Joints; non submerged:
   1. Two-Component Urethane Sealant:
      a. Urethane-based, 2-part elastomeric sealant complying with the following:
         1) FS TT-S-00227E: Type II (non-sag) Class A.
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794: (Minimum 5 lbs/linear inch with no adhesion failure): 28 lbs.
         3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
         4) Stain and color change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
         5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
      b. Product and Manufacturer: Provide one of the following:
         1) Sonolastic NP 2 by Sonneborn Building Products, Division of Chemrex, Inc.
         2) Dymeric by Tremco.
         3) Or equal.

C. Exterior and Interior Horizontal Joints; non submerged:
   1. Two-Component Polyurethane Sealant:
      a. Polyurethane-based, 2-part elastomeric sealant complying with the following:
         1) FS TT-S-00227E, Type I (self-leveling) Class A.
         3) Hardness (Standard Conditions), ASTM C 661: 35 to 45.
         4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
         5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
      b. Product and Manufacturer: Provide one of the following:
         1) 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 caulking 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 ++
DIVISION 8
DOORS AND WINDOWS
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SECTION 08120

ALUMINUM DOORS AND FRAMES

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 aluminum doors and frames Work.
   2. The extent of aluminum doors and frames Work is shown on the Drawings.
   3. The types of aluminum doors and frames Work required includes, but is not necessarily limited to, the following:
      a. Flush doors and frames.
      b. Transom.
      c. Miscellaneous accessories and fasteners.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Continuously engaged in manufacturing of doors of similar type to that specified, with a minimum of 5 years successful experience.
   2. Door and frame components from same manufacturer.
   3. Evidence of a compliant documented quality management system.

B. Reference Standards: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturer's corresponding standard systems.
   1. Aluminum Association (AA), Standards and Finish Designations.
   2. ASTM E 283-04, Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors under Specified Pressure Differences across the Specimen
   4. ASTM D 6670-01, Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products
   5. ASTM D 1621-10, Standard Test Method for Compressive Properties of Rigid Cellular Plastics
7. ASTM D 2126, Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
8. NAAMM, Metal Finishes Manual (AMP 500-06)

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
1. Three samples of each required aluminum finish, on 12-inch long extrusions or 6-inch square sheets, of the alloys to be used for the Work. Where normal color and texture variations are to be expected, include two or more units in each sample, to show the range of such variations.
2. Samples shall be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the exclusive responsibility of CONTRACTOR.
3. Refer to and comply with the requirements of Section 01333, Samples.

B. Shop Drawings: Submit for approval the following:
1. Fabrication and installation drawings of aluminum 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, details of joints and connections. Show all door and frame reinforcements.
2. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown on the Drawings. Refer to and comply with the requirements of Section 08060, Door Schedule.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying opening door mark and manufacturer. Inspect doors and frames upon delivery for damage. 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 as directed by the ENGINEER.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions. Place units up off the floors in a manner that will prevent corrosion and damage. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If the cardboard wrapper on the door becomes wet, remove the carton immediately. Provide a 1/4-inch space between stacked doors to promote air circulation. Refer to and comply with the requirements of 01661, Storage of Materials and Equipment.

C. Handling: Protect materials and finish from damage during handling and installation.
1.5 WARRANTY

A. Warrant doors, frames, and factory hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.

B. Warranty Period: Submit written warranty signed by the manufacturer.

C. CONTRACTOR to replace aluminum 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, delaminating 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 MATERIALS

A. Aluminum Extrusions: Provide aluminum made from prime-equivalent billet that is produced from 100% reprocessed 6063-T6, or equal, alloy recovered from industrial processes: ASTM B 221. Alloy and Temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.

B. Aluminum Face Sheets:
   1. Material: 0.062-inch thick aluminum made from prime-equivalent billet that is produced from 100% reprocessed 6063-T6, or equal, alloy recovered from industrial processes: ASTM B 221. Alloy and Temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.
   2. Provide smooth sheet for exposed faces of doors and panels, except as otherwise specified.

C. Core:
   2. Density: Minimum of 5 pounds per cubic foot.

D. Cutouts:
   1. Manufacture doors with cutouts for required vision lites, louvers, and panels.
   2. Factory install vision lites, louvers, and panels.
E. Hardware:
   1. Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
   2. Factory install hardware.

F. Fasteners:
   1. Material: Aluminum, 18-8 stainless steel, or other non-corrosive metal.
   2. Compatibility: Compatible with items to be fastened.
   3. Exposed Fasteners: Screws with finish matching items to be fastened.

G. Reinforcement and Brackets: Manufacturer’s standard formed or fabricated aluminum units, of shapes, plates or bars.

H. Inserts: For required anchorage into concrete or masonry work, furnish inserts of 12 gage steel stainless steel after fabrication.

I. Expansion Anchor Devices: Stainless steel, drilled-in, expansion bolt anchors.

2.2 FABRICATION

A. General:
   1. Sizes and Profiles: Required sizes for door and frame units, and profile requirements shall be as indicated on the Drawings.
   2. Coordination of Fabrication: Field measure before fabrication and show recorded measurements on shop drawings.
   3. Assembly:
      a. Complete cutting, fitting, forming, drilling, and grinding of metal before assembly.
      b. Remove burrs from cut edges.
   4. Fit:
      a. Maintain continuity of line and accurate relation of planes and angles.
      b. Secure attachments and support at mechanical joints with hairline fit at contacting members.

B. Flush Type Aluminum Doors Construction:
   2. Stiles and Rails: Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T6, or equal, alloy recovered from industrial processes, minimum of 2-5/16-inch depth.
   4. Provide joinery of 3/8-inch diameter full-width tie rods through extruded splines top and bottom integral to standard tubular shaped stiles and rails reinforced to accept hardware as specified.
5. Securing Internal Door Extrusions: 3/16-inch angle blocks and locking hex nuts for joinery. Welds, glue, or other methods are not acceptable.

6. Furnish extruded stiles and rails with integral reglets to accept face sheets. Lock face sheets into place to permit flush appearance.

7. Rail caps or other face sheet capture methods are not acceptable.

8. Extrude top and bottom rail legs for interlocking continuous weather bar.

9. Meeting Stiles: Pile brush weather seals. Extrude meeting stile to include integral pocket to accept pile brush weather seals.

10. Bottom of Door: Install bottom weather bar with nylon brush weather stripping into extruded interlocking edge of bottom rail.

11. Glue: Use of glue to bond sheet to core or extrusions is not acceptable.

12. Product and Manufacturer: Provide one of the following:
   a. SL16 Aluminum Flush Door and Aluminum Tubular Frame System, Special-Lite, Inc.
   b. Or Equal.

C. Aluminum Door Framing Systems

1. Tubular Framing:
   a. Size and Type: As indicated on the Drawings.
   b. Materials: Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T6 alloy recovered from industrial processes, 1/8-inch minimum wall thickness.
   c. Applied Door Stops: 0.625-inch high, with screws and weather stripping. Doorstop shall incorporate pressure gasketing for weathering seal. Counterpunch fastener holes in door stop to preserve full metal thickness under fastener head.
   d. Frame Members: Box type with 4 enclosed sides. Open-back framing is not acceptable.
   e. Caulking: Caulk joints before assembling frame members.
   f. Joints:
      1. Secure joints with fasteners.
      2. Provide hairline butt joint appearance.
   g. Field Fabrication: Field fabrication of framing using stick material is not acceptable.
   h. Applied Stops: For side, transom, and borrowed lites and panels. Applied stops shall incorporate pressure gasketing for weathering seal. Reinforce with solid bar stock fill for frame hardware attachments.
   i. Hardware:
      1. Premachine and reinforce frame members for hardware in accordance with manufacturer's standards and hardware schedule.
      2. Factory install hardware.
   j. Anchors:
      1. Anchors appropriate for wall conditions to anchor framing to wall materials.
2. Door jamb and header mounting holes shall be spaced no more than 24 inches apart.
3. Secure head and sill members of transom, side lites, and similar conditions.
   k. Side Lites:
      1. Factory preassemble side lites to greatest extent possible.
      2. Mark frame assemblies according to location.

2.3 HARDWARE

A. Flush Doors: Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.

B. Factory install hardware.

2.4 ALUMINUM FINISHES

A. General:
   1. Preparation: After fabrication of doors and frames, but before lamination of panels, prepare the aluminum surfaces for finishing in accordance with the aluminum producer’s recommendations and standards of the finisher or processor. Process all components of each assembly simultaneously to attain complete uniformity of color.
   2. Samples:
      a. Comply with industry standard colors and texture samples. Establish samples of the required finish, for ENGINEER’S acceptance, prior to fabrication of the Work. ENGINEER reserves the right to reject material finishes with objectionable variations from the established samples.
      b. Prepare samples on extrusions and sheets of the exact alloys to be used for the Work, and show range of natural variations to be expected in finished Work, by duplicate samples of varying color and texture.

B. Anodized Finishes: NAAMM AA-M10-C22-A42, (Class 1 minimum thickness of 0.7- mils).

C. Painted 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 material. Comply 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
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.

4. Apply finish coating over the primer 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. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to the ENGINEER.
   a. Weathering, ASTM D 4214: Chalking, not more than No. 8, after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
   b. Color Change, ASTM D 2244: No greater than 5 N.B.S. 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 D 2247: Few scattered blisters no larger than ASTM No. 4, after 1,000 hours.
   d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16-inch creep from areas scribed to bare metal after 500 hours.
   e. Dry Adhesion: No pick-off when tape tested over 1/16-inch cross hatch.
   f. Wet Adhesion: No pick-off when tape tested over 1/16-inch cross hatch; extruded material only.
   g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after one hour immersion in distilled boiling water.
   h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80±10°F after 500 hours.
   i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67 minimum.
   j. Gloss, ASTM D 523: 30±5 reflectivity at 60°F.
   k. Pencil Hardness: F minimum.
   l. Dry Film Thickness: Primer, 0.2 to 0.4 mils polyvinylidene fluoride based coating, 0.7 to 1.5 mils.
   m. Solvent Resistance: 100 Double MEK rubs minimum.
   n. Flexibility, ASTM D 522: No cracking prior to metal fracture.
   o. Acid Resistance, ASTM D 1308: 16 hour spot test with five percent hydrochloric acid – no effect.
   q. Color to be selected by the ENGINEER from manufacturer’s standard and custom colors.
   r. Product and Manufacturer: Provide one of the following:
PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which aluminum 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.

3.2 INSTALLATION

A. Comply with manufacturer’s specifications and recommendations for the installation of aluminum doors and frames.

B. Set units plumb, level and true to line, without warp or rack of frames, doors or panels. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 ADJUSTMENT AND CLEANING

A. Clean aluminum surfaces promptly after installation of frames and doors. Remove excess glazing and sealant compounds, dirt and other substances.

B. Where protective coating has been supplied, remove coating completely as soon as the completion of construction activities no longer requires its retention.

C. 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.
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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. Ventilating items to be painted include, but are not limited to the following:
         1) Piping, pipe insulation, pipe hangers, and supports.
         2) Ductwork and insulation.
         3) Equipment, and supports.
         4) 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 manufacturer's 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 below grade, 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. ENGINEER reserves the right to select all non-standard colors for all paint systems specified within the ability of manufacturer to produce such non-standard colors. CONTRACTOR shall supply such colors, at no additional cost to OWNER.

2. Color Coding of Pipelines, Valves, Equipment and Ducts:
   a. In general, all color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1 and CFR 1910.144. Provide color-coding for pipelines included in Paragraph 1.1.F.3.b, Pipeline Color Table, for specified pipelines.
   b. For equipment located on roofs or where exposed-to-view such as on exterior building facades, or in offices or lobbies, the color shall be selected by ENGINEER.

3. Color Coding of Pipelines and Equipment:
   a. Finish coats of paint for pipelines and equipment shall be coded in basic colors. Colors shall be brilliant, distinctive shades matching the following safety colors in accordance with ANSI Z535.1 color specifications for safety colors and other primary colors:

   **TABLE OF STANDARD COLORS**

<table>
<thead>
<tr>
<th>COLOR</th>
<th>DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Black - 35GR</td>
</tr>
<tr>
<td>Blue</td>
<td>Safety Blue - 11SF</td>
</tr>
<tr>
<td>Brown</td>
<td>Chipmunk - YB23</td>
</tr>
<tr>
<td>Charcoal</td>
<td>Graphite - GR32</td>
</tr>
<tr>
<td>Gray</td>
<td>Gray-ANSI 61 - 33GR</td>
</tr>
<tr>
<td>Green</td>
<td>Safety Green - 09SF</td>
</tr>
<tr>
<td>Light Gray</td>
<td>Light Gray - 32GR</td>
</tr>
<tr>
<td>Light Green</td>
<td>Misty Jade - GB38</td>
</tr>
<tr>
<td>Orange</td>
<td>Safety Orange - 04SF</td>
</tr>
<tr>
<td>Red</td>
<td>Safety Red - 06SF</td>
</tr>
<tr>
<td>White</td>
<td>White - 00WH</td>
</tr>
<tr>
<td>Yellow</td>
<td>Safety Yellow - 02SF</td>
</tr>
<tr>
<td>D. Gray</td>
<td>Sinker - 46GR</td>
</tr>
<tr>
<td>Lt. Blue</td>
<td>Clear Sky - 26BL</td>
</tr>
<tr>
<td>Dk. Blue</td>
<td>KC Blue - 21BL</td>
</tr>
<tr>
<td>Medium Green</td>
<td>Linden - 27GN</td>
</tr>
<tr>
<td>Dk. Green</td>
<td>Hunter Green - 08SF</td>
</tr>
<tr>
<td>Purple</td>
<td>Safety Purple - 14SF</td>
</tr>
</tbody>
</table>

*Color designations are provided as Tnemec Company, Incorporated paint color numbers and are provided as a standard of quality; equivalent colors matching these colors will be acceptable to ENGINEER. Provide
ENGINEER with direct color comparisons of color numbers available from manufacturer submitted at time of Shop Drawing submission.

4. General Color Code: Unless otherwise specified, the following color code shall be used:

### PIPING AND SIGN COLOR CODE

#### SAMPLE LINE PIPING

<table>
<thead>
<tr>
<th>PIPING AND LEGEND</th>
<th>PIPING COLOR</th>
<th>LETTERING COLOR</th>
<th>BACKGROUND COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable Water</td>
<td>Lt. Blue</td>
<td>Black</td>
<td>None</td>
</tr>
</tbody>
</table>

#### CHEMICALS

<table>
<thead>
<tr>
<th>PIPING AND LEGEND</th>
<th>PIPING COLOR</th>
<th>LETTERING COLOR</th>
<th>BACKGROUND COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine Solution</td>
<td>Yellow</td>
<td>Black</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

#### DISINFECTANTS

<table>
<thead>
<tr>
<th>PIPING AND LEGEND</th>
<th>PIPING COLOR</th>
<th>LETTERING COLOR</th>
<th>BACKGROUND COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine - Solution</td>
<td>Yellow</td>
<td>Black</td>
<td>None</td>
</tr>
</tbody>
</table>

5. After approval by ENGINEER of colors and Shop Drawing submittals and prior to beginning painting Work, ENGINEER will furnish color schedules for surfaces to be painted.

6. Abbreviations and Symbols:
   a. Abbreviations and symbols used in Tables are explained in Article 2.2, below, and provide information on generic composition of the required materials, manufacturers, number of coats and their dry mil film thickness per coat (DMFTPC) and coverage for calculating the required number of gallons for the Work.

### 1.2 REFERENCE STANDARDS

A. Insure all referenced standards are used according to the standard’s most current version.

B. ASTM International (ASTM):
   1. ASTM C 1538/1538M, Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method
   2. ASTM D 16, Standard Terminology Relating to Paint, Varnish, Lacquer and Related Products
   3. ASTM D 3359, Methods for Measuring Adhesion by Tape Test. Method A.
   4. ASTM D 3960, Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coating
   5. ASTM D 4227, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces
6. ASTM D 4228, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces
7. ASTM D 4258, Practice for Surface Cleaning Concrete for Coating.
8. ASTM D 4259, Practice for Abrading Concrete.
9. ASTM D 4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
10. ASTM D 4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surface
11. ASTM D 4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
12. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed Air.
13. ASTM D 4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel. Methods B or C
15. ASTM D 6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
16. ASTM D 7234, Pull-Off Adhesion test of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
18. ASTM E 797/797M, Measuring Thickness by Manuel Ultrasonic Pulse-Echo Contact Method
19. ASTM F 22, Hydrophobic Surface Films by the Water Break Test
20. ASTM F 1869, Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

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.
   3. NACE Publication 6D-173, A Manual for Painter Safety

E. National Bureau of Standards (NBS)
   1. Certified Coating Thickness Calibration Standards.

F. National Fire Protection Association (NFPA)

G. The Society for Protective Coatings (SSPC)
1. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements (Level 3)
2. SP 1, Solvent Cleaning
3. SP 2, Hand Tool Cleaning
4. SP 3, Power Tool Cleaning
5. SP-15, Commercial Grade Power-Tool Cleaning
6. SSPC Painting Manuel Volume 1, Good Painting Practice Structures
7. SSPC - Volume 2, Systems and Specifications.
8. SSPC - VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
9. SSPC - VIS 2, Visual Standard for Evaluating Degree of Rusting on Painted Steel Surfaces
10. SSPC VIS 3, Guide and Reference Photographs for Steel Surfaces Prepared By Power and Hand Tool Cleaning
11. SSPC Guide 6, Containing Debris Generated During Paint Removal Operation
12. SSPC Guide 12, Guide for Illumination of Industrial Projects

H. The Society for Protective Coatings/NACE International (SSPC/NACE)
   1. SP 5/NACE NO. 1, White Metal Blast Cleaning
   2. SP 10/NACE No. 2, Near-White Blast Cleaning
   3. SP 6/NACE No.3, Commercial Blast Cleaning
   4. SP 7/NACE No. 4, Brush-off Blast Cleaning
   5. SP 13/NACE No. 6, Surface Preparation of Concrete

I. National Association of Pipe Fabricators, Inc.
   NAPF 500-03 (SURFACE PREPARATION STANDARD FOR DUCTILE IRON PIPE AND FITTINGS IN EXPOSED LOCATIONS RECEIVING SPECIAL EXTERNAL COATINGS AND/OR SPECIAL INTERNAL LININGS
   1. 500-03-01, Solvent Cleaning
   2. 500-03-02, Hand Tool Cleaning
   3. 500-03 -03, Poor Tool Cleaning
   4. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe
   5. 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings

J. The International Organization for Standardization (ISO)
   1. ISO 8502-3, Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)

K. Code of Federal Regulations

1.3 DEFINITIONS

A. Specific coating terminology used in this Section shall be in accordance with the definitions in ASTM D 16, ASTM D 3960 and the following definitions:
   1. The term "paint" includes pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate or finish coats.
2. The term “resurfacer” as used herein means an epoxy polymer modified cementitious material used to restore the concrete substrate to provide a contiguous concrete surface for subsequent lining materials.

3. The term “coating” and “lining” as used herein are considered interchangeable and mean coating systems materials, including any applicable resinous primers and finish coats that function to provide protection of steel or concrete substrates.

4. The terms “coating system” and “lining system” as used herein are considered interchangeable and mean all total resurfacing and coating materials combined to function as a total system to provide the designed protection.

5. The term "exposed" means all items not covered with cement plaster, concrete or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. Exposed-to-view surfaces also include those areas visible after permanent or built in fixtures, convector covers, ceiling tile, covers for finned tube radiation, grilles, etc. are in-place, in areas scheduled to be painted.

6. Dry Film Thickness (DFT): The thickness of one fully cured continuous application of coating.

7. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the Work.

8. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.

9. Barrier Coat: A physical barrier, i.e. coating, between the substrate and it’s environment by keeping oxygen, moisture and other chemicals away from the substrate.

10. Photochemically Reactive Organic Material: Any organic material that will react with oxygen, excited oxygen, ozone or other free radicals generated by the action of sunlight on components in the atmosphere giving rise to secondary contaminants and reaction intermediates in the atmosphere which can have detrimental effects.

11. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter or pounds per gallon.

12. Touch-Up Painting: The application of a paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

13. Painter: Installer or applicator is the person or persons actually installing or applying the coating and/or lining in the field at the Project site.

14. The term Independent NACE CCI 3: The inspection body and its staff shall not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular they shall not become directly involved in the design, manufacture, supply, installation, user or maintenance of the items inspected, or similar competitive items. They are also a person and/or persons (NACE Certified Coating Inspector) that has satisfactorily completed NACE CIP program and is still actively certified by NACE International.

15. Approved Factory Finish: Finish on a product in compliance with the finish specified in the section where the product is specified.

16. Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to frequent condensation, spillage or splash of a corrosive material such as water, wastewater, or
17. Highly Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to frequent condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or chronic exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range of 5 - 9.

18. Holiday: A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating. May also be identified as a holiday or pinhole.

19. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

20. Exposed Surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.

21. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils (1/1000 inch).

22. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

23. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

1.4 QUALITY ASSURANCE

A. Applicators’ Requirements

1. If any requirements of this specification in conflict with a referenced standard, the more stringent requirement shall apply.

2. Minimum of 10 (ten) years of experience regularly performing the application of coating and/or lining materials, with documented skill and successful experience in the application of the types of materials.

3. Submit list of projects of similar size and complexity along with names of persons and their work experience. This must include evidence of worker training and qualification programs. Only those submitted and approved persons by the ENGINEER will be permitted to work on the project.

4. Qualifying experience shall include at least three previous projects of similar magnitude and complexity to this project that have been completed not less than 18 months prior to submission of qualifications to ENGINEER.

5. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
   a. Name of project
   b. Names and telephone numbers of owners, architects or engineers responsible for projects.
   c. Approximate contract cost of the paint materials.
   d. Amount of area installed.

6. Submit in writing to the ENGINEER acceptability by the coating manufacturer.

7. Personnel are to be completely trained and experienced in the proper use of all specified/submitted coating and lining materials, surface preparation and application equipment being used for the project. No person shall work on this project unless they have been previously approved by the ENGINEER.

B. Source Quality Control

1. Obtain materials only from manufacturers who will provide the services of a qualified manufacturer's representative at the site at the commencement of painting Work to advise on
materials, mock-ups, installation and finishing techniques, at the completion of the Work to
advise ENGINEER on the acceptability of completed Work, and during the course of the
Work as may be requested by ENGINEER.

2. Certify long-term compatibility of all coatings with intended service exposures.

3. Do not submit products that do not meet or exceed the performance criteria. All submitted
coating and/or lining system must be able to provide long-term protection and performance
within its intended service environment. Products exceeding current VOC limits will not be
approved.

4. ENGINEER may review manufacturer’s recommendations concerning methods of
installation and number of coats of paint for each painting system. Prepare cost estimates
based on painting systems, number of coats, coverages and installation methods specified.

5. All proposed "or equal" products shall be submitted 20 working days prior to the beginning
of work with direct comparison to products specified including information on performance
criteria adhesion, color and gloss retention, percent solids, VOC’s per gallon, application
methods, case histories and re-coat ability after curing etc.

6. "Equal or better" manufacturers shall furnish the same color selection as the manufacturers
specified, including intense chroma and custom pigmented colors in all painting systems.

7. Color Pigments: Provide pure, nonfading, applicable types to suit the surfaces and services
indicated. Comply with the following:
   a. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by
governing authorities having jurisdiction.
   b. Areas subject to hydrogen sulfide fume exposure shall be identified by ENGINEER.
      Manufacturer shall notify ENGINEER of colors that are not suitable for long-term color
      retention in such areas.
   c. Comply with manufacturer’s recommendations on preventing coating contact with levels
      of carbon dioxide and carbon monoxide that may cause yellowing during application and
      initial stages of curing of paint coatings.

8. Obtain each product from only one manufacturer. Multiple manufacturing sources for the
same system component will not be approved by ENGINEER.

9. Certify product shelf life history for each product source for materials manufactured by the
same manufacturer, but purchased and stored at different locations or obtained from different
sources.

10. Constantly store materials to be used in the painting according with the manufacturers
approved current written recommendations, for not more than six months. Certify to
ENGINEER that painting materials have been manufactured within six months of installation
and have not, nor will be, subjected to freezing temperatures.

11. Provide the services of a qualified manufacturer's representative to the Project site to observe
the initial commencement of surface preparation and each coating's application.
Manufacturer’s representative will advise on materials, surface preparation, coating
applications and finishing techniques. Once completed the manufacturer’s representative will
provide a written report certifying that all observed surface preparation and coating
application(s) have been completed according to the manufacturer's current recommendations
and requirements. This certification report must be received 7 (seven) calendar days after the
last site visit by the manufacturer.

12. Provide in writing that the specified and applied coating or lining system is the correct
system for the long-term protection and performance of the environmental exposures it will
be subjected.

13. Provide the services of a qualified manufacturer's representative to the Project site at the
completion of work to inspect the Work. The qualified manufacturer's representative to
provide a manufacturer’s report stating any deficiencies in the coatings system, if any, noted during the final inspection. The report must be submitted to the 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 D 4227 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces or ASTM D 4228 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces.
4. ENGINEER may approve or disapprove each component of each painting system on an individual component basis.
5. Coating or lining system Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material.
6. Coating or lining system Work advanced without approved mock-ups shall be stopped, and mock-ups prepared for approval by ENGINEER. If any coatings or linings have been applied before an approved mock up standard has been agreed upon in writing by all parties, the ENGINEER has the authority to have those applied coatings or linings completely removed and reapplied at CONTRACTORS expense.

E. Requirements of Regulatory Agencies: Surface preparation and application of coatings shall be performed in compliance with all applicable federal, state and local occupational safety and health regulations and Maricopa County Air Pollution Control Regulations. Insure that all required certifications for all regulatory agencies current and readily available upon request.
1. Obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins and as required by applicable regulations. Provide forced ventilation in all areas where inadequate ventilation exists.

2. Painting systems for surfaces in contact with potable water, or water being treated for potable use, shall be NSF approved and shall not impart any taste or odor to the water or result in any organic or inorganic content in excess of the maximum allowable contaminant level established by governing authorities having jurisdiction. All such painting systems shall be approved by the applicable regulatory agency. Revise painting systems specified herein to provide manufacturer's regulatory agency approved painting system(s) where required.

3. Comply with the regulations of governing authorities having jurisdiction for air quality and material disposal regulations. Revise painting systems specified herein in order to provide manufacturer's regulatory agency approved painting systems, where required.

4. Comply with governing authorities having jurisdiction for blast cleaning operations, confined space entry and disposition of spent abrasive and debris.

F. Pre-Application Meeting:

1. A pre-application meeting MUST take place at the job-site or mutually agreed upon site a minimum 3 (three) weeks before the application of any coating or lining work proceeding. Attendance is required of all principal decision making parties directly affecting work of this section, including OWNER, ENGINEER, CONTRACTOR, COATING MANUFACTURER’S REPRESENTATIVE and COATING INSPECTOR etc. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures relating to the painting Work, including but not necessarily limited to, the following:

   a. Review Project Coating Specification, Project requirements, including Contract Documents, Project Schedule, approved Shop Drawings, pending and approved Change Orders and requests for information.

   b. Field quality control: Contractors responsibilities, i.e providing written daily reports and review required samples and submittals, both completed and yet to be completed.

   c. Review status of surfaces including drying, surface preparations and similar considerations.

   d. Review availability of materials, tradesman, equipment and facilities needed to make progress, avoid delays and protect the Work from damaging conditions.

   e. Coating Inspector’s authority and responsibilities, required inspections, testing services, certifications and quality control procedures.

   f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions. Supplemental heating sources, as may be required to continue the Work under low temperature conditions, shall be in operating order and acceptable to paint applicator.

   g. Review methods for complying with regulations of governing authorities having jurisdiction, such as compliance with environmental protection, health, safety, fire and similar regulations.

   h. Material storage requirements

   i. Protection of surfaces not scheduled to be coated

   j. Application requirements and procedures

   k. Protection of coating systems
2. Provide meeting minutes to all parties for review and possible clarification. Should any correction to the meeting minutes be required, the minutes should be corrected and resubmitted to all parties.

3. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

4. Record any revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

G. Maintain a Paint Application Log containing the information as shown on the log attached at the end of this Section. The Paint Application Log shall be maintained on a daily basis for all areas where the Work is being performed. The Paint Application Log shall be turned over to the ENGINEER by 9:00 a.m. the following day that the work was performed. The log shall include the following:

1. Date.
2. Time.
3. Weather condition (at work location).
4. Air temperature (at work location).
5. Surface temperature (at work location).
6. Dew point (at work location).
7. Humidity (at work location).
8. Material temperature (Before (Separately) and Mixed (Combined)).
9. Location/area square footage.
10. Description of Work performed.
11. Materials used, colors and batch numbers, quantity of materials used (not including waste).
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
   2. Manufacture
   3. Color name and number
   4. Batch or lot number
   5. Date of manufacture.
   6. Mixing and thinning instructions.
   7. Federal Specification Number if applicable.
   8. Application and mixing instructions.
   9. Hazardous material identification label
   10. Shelf life date.
   11. Storage requirements. Submit storage and application temperature requirements for all coating system materials

B. Storage of Materials:
   1. Store materials in a clean dry area and within temperature range according to the coating manufacturer's current written instructions
   2. Keep containers sealed until ready for use.

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3. Do not use materials beyond manufacturer’s shelf life limits.
4. All coating shall be delivered to the shop or job site in original, unopened containers with labels intact. Minor damage to containers is acceptable provided the container has not been punctured or the lid seal broken.
5. Each container of coating shall be clearly marked or labeled to show coating identification, date of manufacture, batch number, and other information as needed to meet regulatory requirements. Each type of coating shall be accompanied by the manufacturer’s Material Safety Data Sheet (MSDS) and product data sheet containing information such as basic chemical composition, acceptable weather conditions for application, and proper storing and mixing.
6. All containers of coating shall remain unopened until required for use. No more containers of coating shall be opened than will be applied that day. The label information shall be legible and shall be checked at the time of use.
7. Coating which has livered, gelled, or otherwise deteriorated during storage shall not be used; however, thixotropic materials which can be stirred to attain normal consistency may be used.
8. The oldest coating of each kind that is in acceptable condition shall be used first. In every case, the coating is to be used before its shelf life has expired. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.
9. Coatings shall be stored in original unopened containers in weather tight spaces where the temperature is maintained between 60 °F and 90 °F unless otherwise recommended in writing by the manufacturer. The coating temperature shall be brought to the coating manufacturer current written recommended application temperature before use. Materials shall be stored according to the manufacturer’s recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions.
10. Flammable materials shall be stored according to state and local codes.
11. Store all materials only in area or areas designated by the ENGINEER. Confine mixing, thinning, clean up and associated operations, and storage of materials related debris before authorized disposal, to these areas. All materials are to be stored on pallets or similar storage handling skids off the ground.
12. Mix all lining materials in an enclosed mixing area designated by the ENGINEER. This enclosed area must protect the mixing operation and materials from direct sunlight, inclement weather, freezing, or other means of damage or contamination. Protect all other concrete and metallic surfaces and finishes from any spillage of material(s) within the mixing area. The material temperature should be between 70o F and 90o F before application, unless noted otherwise on the current product data sheet.
13. Do not use floor drains, dikes or storm drains for disposal of coating system materials. Provide for the safe removal and lawful disposal of all waste materials.
14. Take all precautions and implement all measures necessary to avert potential hazards associated with the resurfacing system materials as described on the pertinent Material Safety Data Sheets or container labels.
15. Deliver all materials to the job site in their original, unopened containers. Each container shall bear the Manufacturer’s name and label.
16. Maintain the storage and the environmental climate of that area for all coating materials that they will be using unless otherwise agreed upon.
17. Handling: Protect materials during handling and application to prevent damage or contamination

1.7 SAFETY
A. Conduct the following safety items:
   1. Comply with all federal, state and local regulations as well as with the provisions outlined in NACE Pub. 6D-173, “A Manual for Painter Safety”
   2. Provide personnel with all safety equipment necessary to protect them during any phase of the work according to all current OSHA Standards.
   3. Adhere to all OSHA requirements with regard to permitted confined space including providing all equipment and personnel necessary.
   4. Erect and maintain scaffolding according to OSHA standards.
   5. No work shall be performed until the appropriate Work Requests and Lockouts are approved by the ENGINEER. The Work Request system provides a mechanism to advise plant staff of a contractor’s work activities. The Lock Out /Tag Out system is a safety procedure to prevent unintended equipment activation.
   6. Keep any flammable materials such as cleaning solvents, thinners, or resurfacing materials away from open flames, sparks or temperatures higher than 150 F. Drums containing flammable materials shall be grounded. Flammable materials not being utilized shall be maintained in their on-site storage area.
   7. Power tools are to be in good working order to avoid open sparking. No spark producing tools shall be utilized in restricted areas as indicated herein.
   8. Maintain a clean work area and furnish Underwriter’s Laboratories approved fire extinguishers on-hand.
   9. Workers performing abrasive blasting operations shall wear a fresh air supplied protective helmet and hood and personal protective clothing acceptable to industry standards and all government regulations.
   10. Workers performing coating operations shall wear the appropriate personal protective equipment, clothing, and NIOSH approved respirator acceptable to industry standards and all government regulations.
   11. Dispose of rags used for wiping up resurfacing materials, solvents, and thinners by drenching them with water and placing in a metal container with a tight fitting metal cover. Complete this disposal process at the end of each day. Final disposal of these materials is the CONTRACTORS’s responsibility.
   12. Matches, flames, or sparks resulting from any source including welding, must be removed from the work area during coating work. Smoking is NOT permitted accept for designated areas.

1.8 PROJECT CONDITIONS

A. Site Facilities:
   1. Supplemental heat sources, as may be required to maintain both ambient and surface temperatures within the range recommended by the manufacturer for paint system applications, are not available at the site.
   2. Provide provisions for all supplemental heat energy sources, power, equipment and operating, maintenance and temperature monitoring personnel.
   3. Do not use heat sources, which emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent all such heat sources to the exterior such that paint systems are unaffected by exhaust products.

B. Existing Conditions:
   1. Provide lighting (If Required) for all work areas as prescribed in SSPC Guide 12
2. Existing materials specified to be painted as part of the Work shall have their surfaces prepared to meet the requirements of the painting systems specified. Where existing paint systems will provide the substrate for painting systems specified, provide adhesion testing on existing surfaces to be painted according to the coating manufacturers recommendations. Abrasive blasting, scraping or other abrading or surface film removal, or preparatory techniques as approved by ENGINEER shall be provided as part of the Work.

3. Before painting is started in any area, all surfaces to be painted and floors shall be cleaned of all dust using commercial vacuum cleaning equipment and dust containment.

4. Apply coatings to dust free surfaces. Test surfaces for cleanliness according to ISO 8502-3 (Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness - Part 3 Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method). Randomly test prepared surfaces at rate of 8 tests for the first 1000 square feet. Afterwards conduct 3 tests for each additional 1000 square feet. Provide 3 additional tests for each failed test or questionable test. Turn in test tapes results with Daily Inspection Reports.

5. After painting operations begin in a given area cleaning shall be done only with commercial vacuum cleaning equipment and dust containment systems.

C. Environmental Requirements

1. If required to maintain project schedule, Provide and utilize dehumidification and ventilation equipment to control humidity, temperature, and vapor levels in from beginning of the surface preparation process through coating application and for seven days after the last coating is applied. System shall maintain vapor concentrations at or below 10 percent of Lower Explosive Limit (LEL). System may incorporate any combination of solid desiccant and direct expansion refrigeration equipment. No liquid, granular, calcium chloride, or lithium chloride drying systems will be accepted. Use only electric, indirect fired combustion, indirect friction, or steam coil auxiliary heaters. System shall be compatible with removal of dust and solvent vapors, and shall have fail-safe measures to ensure reliability during operations.

2. If dehumidification and ventilation equipment is not already being used, ventilate interior areas such as water tanks (potable or non-potable) and other containment service areas according to written procedures outlined by the ENGINEER and/or the coating manufacturer.

3. Provide enclosures for other areas or items that may require protection from the inclement weather or other detrimental effects so the project can continue.

4. Apply water-base paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 55°F and 90°F, unless otherwise permitted by the paint manufacturer's current printed instructions.

5. Surfaces to be painted shall dry to the touch and at least 5°F above the dew point temperature and rising. Apply paints only when the temperature of surfaces to be painted, paint material, and the surrounding air temperatures are between 65°F and 95°F, unless otherwise permitted by the paint manufacturer's current printed instructions.

6. Apply paint system within the shortest possible time consistent with manufacturer's approved recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, it shall be removed according to the coating manufacturer written recommendation, and the surface restored before applying the remainder of the coatings.

7. Tanks containing water shall not be painted without specific permission of ENGINEER, and only under conditions where "sweating" of the tank outside surface is not likely to occur within 24 hours of application.
8. Epoxy paints shall not be applied if ambient temperature is expected to go below 50°F within 12 hours of application. Where manufacturer's printed recommendations require a higher minimum ambient temperature, this shall be followed.

9. Do not apply paint in rain, fog or mist; or when the relative humidity exceeds 85 percent; to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during the course of the paint application, unless otherwise permitted in writing by the paint manufacturer's printed instructions.

10. Do not paint pipelines and other hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to manufacturer. Arrange for such surfaces to be brought within acceptable temperature and dew point ranges as part of the painting Work.

11. On substrates such as wood, concrete etc, use methods recommended by the specified manufacturer, the measured moisture content of surfaces shall be verified by the ENGINEER as acceptable prior to the commencement of the painting.

12. Painting may continue during inclement weather only if the areas and surfaces to be painted are enclosed and ambient conditions can be maintained continuously as specified by the paint manufacturer during application and drying periods.

13. Provide adequate illumination (SSPC-Guide 12) and ventilation in all areas where painting operations and inspections are in progress.

14. Install piping markers only after all painting and finish work has been completed and cured.

D. Protection:

1. Cover or otherwise protect finished Work of other trades and surfaces not being painted concurrently or not to be painted.

2. During surface preparation and painting, the facility shall remain in operation. Employ procedures that prevent contamination of the process or cause facility shutdown.

3. Coordinate and schedule surface preparation and painting to avoid exposing employees and others not involved with surface preparation and painting. Provide required personnel safety equipment in compliance with the requirements of governing authorities having jurisdiction.

4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work in any area until ENGINEER approves protection techniques proposed.

5. Provide fire extinguishers and post caution signs warning against smoking and open flame when working with flammable materials.

E. Spent abrasive containing lead and/or chromate paint resulting from the blasting of the "affected surfaces" is classified as a hazardous waste. "Spent abrasive" shall be understood to mean the abrasive generated during the blasting operation, including the spent water imposed over the abrasive flow, paint residue and any other debris.

F. Care shall be exercised to prevent spent abrasive, water or dust from falling on surrounding buildings, unprotected vegetation, walkways, soils, structures and equipment by covering these areas with non-tearing tarps. Spent abrasive collecting on the ground shall be vacuumed regularly to prevent it from becoming windblown. The site shall at all times be kept as clean as possible. At the end of the Work day, all spent abrasive shall be thoroughly vacuumed and the site left with a neat appearance.

G. Spent abrasive resulting from the blasting of the "affected surfaces" shall be captured. Non-tearing tarps or plastic sheathing, platforms, partial or total enclosures, temporary barriers or
structures, or similar containment methods may be employed for this purpose. These methods
must be reviewed by the ENGINEER prior to start of the Work. Provide a detailed procedure
describing the proposed blast cleaning operation, abrasive capture and containment techniques,
and safety measures to avoid the contamination of the natural environment or surrounding
structures.

H. Spent abrasive resulting from the blasting of the "affected surfaces" shall be collected and legally
disposed of by the CONTRACTOR in a legal and responsible manner. Such disposal shall also
be in conformance with all applicable codes, ordinances and regulations for hazardous waste
disposal. All other waste, including spent abrasive generated by the blasting of non-affected
surfaces, shall be disposed by the CONTRACTOR.

I. All reasonable care shall be taken to protect against paint splatter and overspray. Responsibility
for any damage incurred to surrounding property resulting from this work belongs to the
CONTRACTOR.

J. Signs shall be posted, as required, to alert the public of any risks associated with sandblasting
debris, painting overspray, etc. All efforts shall be made to prevent debris from becoming
windblown.

L. Obtain all permits required to perform the Work.

M. 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. Sika Corporation
  2. ICI Devoe
  3. Sherwin Williams
  4. Carboline Protective Coatings
  5. PPG Industries/Amercoat
  6. Raven Lining Systems

2.2 PAINTING SYSTEMS

A. Corrosion Encapsulation Surface Repair:
  1. One of the following or an equivalent product:
     a. Aquatapoxy A-6, as manufactured by Raven Lining Systems.
     b. Sikagard 62 (NSF 61 approved top coat), as manufactured by Sika Corporation.
B. New and Existing Cast-In-Place Concrete associated with all Potable Water Containment Tanks, Reservoirs and Channels at Ambient Temperature; Submerged, and Exterior:
   1. Provide all painting system components specified for all cast-in-place concrete surfaces shown on the Drawings.
   2. Surfac er/Filler (Epoxy Modified Cementitious Mortar)
      a. Coating 1. Tnemec Series 218 MortarClad; 1 parge coat trowel applied; nominal 1/16 inch minimum DFT (actual DFT to depend on the depth of the profile in the concrete after abrasive blasting.)
   3. Finish Coat(s) (100% Solids NSF Certified Polyamine Epoxy)
      a. Tnemec Series 22 or FC22 Epoxoline; 1 or more coats; 30-40 mils DFT

C. New and Existing Ferrous Metals, Structural Steel (not protected by sprayed fireproofing), Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, Above ground Ductile-Iron Piping and Exterior Surfaces of all Ferrous Piping (both exposed and to be later covered with insulation); Non-submerged, Interior: (LEED Compliant through Version 3.0)
   1. Primer (Polyamidoamine Epoxy *)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
   2. Finish Coat (Polyamidoamine Epoxy)
      a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

D. New and Existing Ferrous Metals, Interior Surfaces of Potable Water Storage Reservoirs at Ambient Temperatures, Galvanized Metals and Non-Ferrous Metals and Exterior Surfaces of Piping; Intermittently Submerged and Submerged, Interior and Exterior:
   1. Primer (NSF Certified Organic Zinc Rich)
      a. Tnemec Series 91-H20 Hydro-Zinc; 1 coat 2.5-3.5 mils DFT
   2. Intermediate Coat (NSF Certified Polyamidoamine Epoxy)
      a. Tnemec Series N140 Pota-Pox Plus; 2 coats; 6-8 mils DFT per coat
   3. Finish Coat (NSF Certified Polyamidoamine Epoxy)
      a. Tnemec Series N140 Pota-Pox Plus; 2 coats; 6-8 mils DFT per coat

E. 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

F. 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

G. New and Existing PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior: (LEED Compliant through Version 3.0)
   1. Prime Coat (Self-crosslinking Hydrophobic Acrylic)
a. Tnemec Series 115 Uni-Bond DF; 1 coat; 2-4 mils DFT
2. Finish Coat: (HDP Acrylic Polymer)
   a. Tnemec Series 1029 Enduratone; 1 coat; 2-3 mils DFT

H. Where it is determined that abrasive blasting surface preparation is not feasible use Tnemec
   Series 135 Chembuild as the prime coat.

2.3 SUBSTITUTIONS

   A. No products that decrease the film thickness, the surface preparation, VOC's, solids by volume or
      the generic type of coating specified shall be considered. Approved manufacturers shall furnish
      the same color selection as the manufacturers specified, including accent colors and custom
      colors in all coating systems, and shall document satisfactory performance of their coating system
      For at least three water treatment plants that have been in service at least five years each.

2.4 PIPING MARKERS

   A. General:
      1. For pipes over 3/4-inch outside diameter: Provide painted pipe markers.
      2. For pipes under 3/4-inch outside diameter: Provide aluminum tags, totally compatible with
         service conditions, 1-1/2-inch diameter, with depressed 1/4-inch high black filled letters
         Above 1/2-inch high black filled numbers.
      3. Each marker shall consist of at least one legend descriptive of the function of the pipe and a
         directional arrow.
      4. The size of lettering and marker shall conform to ANSI A13.1.
      5. Location of Markers:
         a. Adjacent to each valve and "T" connection.
         b. At each branch and riser takeoff.
         c. At each pipe passage through a wall, floor and ceiling.
         d. On all horizontal and vertical pipe runs at 25-foot intervals.

PART 3 - EXECUTION

3.1 INSPECTION

   A. Examine the areas and conditions under which painting Work is to be performed and notify
      ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the
      Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a
      manner acceptable to ENGINEER.

   B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise
detrimental to the formation of a durable paint film capable of performing in accordance with
claims made in manufacturer's product literature for the surfaces and conditions encountered. Do
not paint over "UL" or similar labels, including mechanical and electrical Manufacturer
nameplates.

   C. Do not paint over existing paint where there is no assurance that existing paint will provide an
acceptable surface for the long-term adherence and durability of painting systems specified or
where the manufacturer requires removal of all existing paint in order to recommend the use of
the specified painting system.

D. Provide lighting for all work areas to be inspected as prescribed in SSPC Guide 12. No coating
inspections will be conducted until the minimum lighting requirements for inspection is provided.

E. Assure that all surfaces and areas to be inspected will be clean and ready for inspection so the
coating and/or lining system can be immediately applied. No inspections will be conducted if
areas and/or surfaces have dust and debris floating in the air and/or covering the substrates to be
inspected.

F. All expenses due to delays, extra coating inspections etc is the sole responsibly of the
CONTRACTOR

3.2 SURFACE PREPARATION

A. General:
1. Prepare all substrates new or existing according to the coating manufacturers’ current written
guidelines for the submitted coating system and its intended service environment.
2. Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a
minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting
is free of oil and moisture when tested according to ASTM D 4285. Test air quality at each
startup, but in no case less often than every five operating hours.
3. Provide lighting for all work areas as prescribed in SSPC Guide 12.
4. Prior to performing any testing, i.e soluble salts, adhesion, moisture content or vapor,
alkalinity etc all principle parties shall agree upon in writing methods of testing, quantity of
testing, acceptable results, and the proper course of action that will be taken in case the
acceptable limits are not or cannot be met. Excessive moisture, or other conditions, may
impact the Project Schedule.
5. Prior to any surface preparation covered in this section, all surfaces should meet the
acceptable conditions required.
   a. Inspect all surfaces for oil and/or grease contamination using two or more of the
      following inspection techniques. Reject oil and/or grease contaminated surfaces, clean
      [using a water based pH neutral degreaser] in accordance with SSPC SP 1, and recheck
      for contamination until surfaces are free of oil and grease.
         1) Visual Inspection
         2) Water Break Test
         3) Black Light Test
         4) Cloth Rub Test
   b. Water Break Test - Spray atomized mist of distilled water onto surface, and observe for
      water beading. If water "wets" surface rather than beading up, surface can be considered
      free of oil or grease contamination. Beading of water (water forms droplets) is evidence
      of oil or grease contamination.
   c. Black Light Test - Inspect surfaces for oil and grease contamination using the light
      specified in the paragraph Black Light. Use light no more than 12 inches from surface
      unless testing indicates that the specific oil or grease found in tank fluoresce at a greater
distance. Use light in tank that is completely sealed from light infiltration, under a hood,
or at night. Any fluorescing on steel surfaces is an indication of petroleum oil/grease
      contamination. Use either Water Break Test or Cloth Rub Test to confirm both
contaminated and non-contaminated areas detected by Black Light Test. The Black Light Test may not be used during inspection of prepared surfaces for oil and grease contamination unless proven to fluoresce the oil and/or grease found in the specific tank and documented during testing prior to abrasive blasting. Generally, only petroleum oil/grease will fluoresce, however, some may not fluoresce sufficiently to be recognized and other methods, such as the Water Break Test or Cloth Rub Test, must be used to confirm findings of the Black Light Test.

d. Cloth Rub Test - Rub a clean, white, lint free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

6. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items already in-place and that does not require field painting, or provide effective surface-applied protection prior to surface preparation and painting operations.

7. Remove, as necessary, items, which must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved. Surfaces to be painted must be clean, dry and sound before applying any painting system components. Should any surface be found in an unsatisfactory condition, remediate by the best means feasible to provide an acceptable coating condition.

8. Coating products shall not be applied until the ENGINEER has inspected the materials and the coating manufacturer's technical representative has instructed CONTRACTOR and ENGINEER in the surface preparation, mixing and application of each coating.

B. Cast In Place Concrete. Precast Concrete and other Masonry Substrates

1. Test for moisture content of concrete surfaces before commencement of painting Work. There are many tests for moisture in concrete such as ASTM D 4263, ASTM F 1869 or ASTM F 2170. Provide from the submitted coating manufacturer in writing as to which standard they want used and what results must be obtained for satisfactory compliance. Report results to ENGINEER before starting Work.

2. Verify that the pH levels, of the cleaned concrete surfaces to be coated, are 10 to 12 or within the coating manufacturers’ current written acceptable range. The pH of the concrete substrate will be measured using pH indicating papers. The pH testing is to be performed once every 50 square feet (5 square meters). Acceptable pH values can be measured using color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum). Use Hydrion Insta-Check Jumbo 1-12, or equal. The paper shall be touched to the surface once using moderate gloved finger pressure. The surface shall not be wiped or moved laterally to disturb the surface during pH testing. Following the one touch, lift the paper vertically to not "wipe" the surface. Compare the color indicated with the scale provided and record the pH. Spot check any areas that may be questionable with phenolphthalein solution. Where paint system is used to provide chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radius cove base fillets at all equipment pads and containment walls as part of the complete chemical containment paint system Work. Use materials and techniques recommended by the specified Manufacturer.

3. Remove all cast-in-place concrete fins, projections, tie wire, nails and other surface irregularities, which would protrude above the level of finished intermediate fillers and surfacers by chipping and scarification by mechanical abrasion.
4. Using specified filler and surfacer, patch all cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions and grind filler and surfacing compounds smooth and level with adjacent surfaces.

5. Where concrete masonry unit block filler is specified, spot patch holes and cracks with a putty knife using specified block filler to provide smooth finish for large surfaces coating materials can be applied by airless spray and backroll uniformly using a roller with a synthetic nap cover. While the coating material; is still wet a rubber squeegee can be used to provide a smooth finish.

C. Ferrous Metals:
1. Test surfaces for soluble salts, and wash as required, prior to any surface preparation. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require the removal of any barrier to the steel surface, including rust. This procedure may require combinations of wet abrasive blasting, high pressure water washing, and cleaning using a solution of water washing and soluble salts remover. The soluble salts remover shall be a acidic, biodegradable, nontoxic, noncorrosive, and after application, will not interfere with primer adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use clean potable water, or clean potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.

2. Verify that coating manufacturer recommended anchor profiles have been achieved on prepared surfaces using the submitted coatings current guidelines for its intended service environment. Report profiles to ENGINEER using Test Method B or C in compliance with ASTM D 4417.

3. All surface imperfections (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, and slivers) existing or new shall be removed from submerged or non-submerged ferrous metal surfaces. All edges and corners shall be ground to provide a smooth 1/16" radius. New ferrous metal surface imperfections are the responsibility of the manufacturer. Acceptance of the substrate without having these imperfections being corrected becomes the sole responsibility of the CONTRACTOR. Surface imperfections of previously coated ferrous metal surfaces that are being re-coated are the responsibility of the CONTRACTOR to remove or have re-moved.

4. Submerged or non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed shall be prepared according to the coating manufacturers current written guidelines for the submitted coating system and its intended service environment.

5. All shop primed items shall be inspected in the shop by an independent NACE CCI. Any shop applied coated pieces that do not or cannot provide documents for Q/C inspection will be re-prepared and re-coated in the field. The shop coating applicator will be solely responsibility for all financial burdens associated with this remediation.

6. Touchup shop applied prime coats which have damaged or have bare areas, according to SSPC-SP11, (Power Tool Cleaning to Bare Metal) at the time of painting system application, SSPC VIS 3 can be used as a comparison. Tightly adhering coating surrounding the bare metal shall be feather edged a minimum of 1 inch back to provide a clean, dry, sound and smooth transition from bare metal to remaining coating.
7. Remove all surface imperfections (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, slivers) using SSPC-SP2 (Hand Tool Cleaning) and/or SSPC-SP3 (Power Tool Cleaning) before full surface preparation operations begin.

8. Remove all rust and contamination on existing ferrous metals to sound surfaces by power tool cleaning complying with SSPC SP11 to provide a surface profile of not less than one mil.

9. Non-Ferrous Metal Surfaces: Prepare all substrates new or existing according to the coating manufacturers’ current written guidelines for the submitted coating system and its intended service environment.

D. Galvanized (Zinc-Coated) Surfaces: Prepare all substrates new or existing according to the coating manufacturers’ current written guidelines for the submitted coating system and its intended service environment.

E. CPVC Piping and Fiberglass: Prepare all substrates new or existing according to the coating manufacturers’ current written guidelines for the submitted coating system and its intended service environment.

F. Covering on Pipe Insulation:
   1. Remove all oil and surface contaminants as recommended by manufacturer for surface and application required.
   2. Do not cut or damage the insulation in any way.

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.
   - Application equipment must be inspected and approved in writing by coating manufacturer.

2. Temperature and weather conditions:
   - Do not paint surfaces when surface temperature is below as specified in Section 1.8.C. F unless product has been formulated specifically for low temperature application or approved in writing by Engineer and paint manufacturer's authorized representative.
   - 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.
   - Avoid painting surfaces exposed to hot sun.
   - 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.
   - Finish coats shall be applied in the field.
   - 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.
   - All paint systems are "to cover." In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.

5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.

6. Use alternating colors to separate and distinguish the applied coatings.

7.Apply materials under adequate illumination as required under SSPC-Guide 12 Guide for Illumination of Industrial Painting Projects

8. Evenly spread to provide full, smooth coverage. All paint is to be applied in a continuous, monolithic and pinhole free manner.

9. Stripe coat (each coat) with a brush prior before full application. Stripe coats should be applied to edges, corners, crevices, joints, and other difficult to work areas.

10. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contaminate
    - Clean contaminated surfaces before applying next coat
b. Final coat shall be contaminant 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.
   1. ASTM D4541 - Pull-Off Strength of Coatings Using Portable Adhesion Testers
   2. ASTM D7234 - Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
   3. ASTM C1583/C1583M - Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

B. Consult with the coating manufacturer to determine if these or other methods are acceptable. Provide written test methods and qualifications for acceptance to ENGINEER. The number and location of tests shall be sufficient for CONTRACTOR to determine the condition of existing coatings and the suitability of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER a copy of adhesion test results.

C. Painting Records:
   1. Maintain permanent written records of daily Q/C responsibilities.
   2. Verify and record that the coatings and other materials are as specified (i.e., manufacturer, product name & product batch dates).
   3. Verify and record condition of coatings and material along with their storage procedures
   4. Verify and record surface preparation and application of coatings are as specified.
   5. Verify and record coating mixing and thinning procedures, i.e. batch dates, amount mixed, material temperatures, induction time etc.
   6. Verify and record application procedures.
   7. Verify and record environmental conditions one half hour before work starting, then every 2 hours afterwards and once upon completion of work that day. Environmental readings must be obtained in the area that the work is taken place. Environmental readings shall not be obtained from computers, TV or cell phone apps. Readings shall be immediately taken should a sudden change in the climate be observed. Record results using sample forms or similar approved forms.
   8. Verify and record WFT and DFT of each coat of the coating system are as specified using new wet film gauges and certified dry film thickness gauges. Dry film thickness readings shall be done according to SSPC-PA 2 (Level 3)

D. 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

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<th>Hold Point/Inspection Item</th>
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## Coating Material & Mixing Data

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SECTION 13211

INDUSTRIAL MEMBRANE COATING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Industrial Membrane Coating for concrete reservoirs. Coating is a two-component asphalt modified urethane, applied as a cold liquid which rapidly cures to form a seamless, abrasion, corrosion, and chemical resistant waterproofing membrane for applications requiring classification in accordance with ANSI/NSF 61.

1.2 RELATED SECTIONS

A. Related sections include but are not limited to:
B. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
C. Division 1 - General Requirements.

1.3 REFERENCES

A. ACI 201.1R - Making a Condition Survey of Concrete in Service.
E. ASTM D 36 - Softening Point of Bitumen (Ring-and-Ball Apparatus).
F. ASTM D 257 - D-C Resistance or Conductance of Insulating Materials.
G. ASTM D 412 - Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
H. ASTM D 624 - Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
J. ASTM D 751 - Coated Fabrics.
M. ASTM D 1682 - Breaking Load and Elongation of Textile Fabric.
N. ASTM D 2240 - Rubber Property - Durometer Hardness.
P. ASTM D 4060 - Abrasion Resistance of Organic Coatings by the Taber Abraser.
Q. ASTM D 4258 - Surface Cleaning Concrete for Coating.
R. ASTM D 4259 - Abrading Concrete.
S. ASTM D 4263 - Indicating Moisture in Concrete by the Plastic Sheet Method.
T. ASTM D 4285 - Indicating Oil or Water in Compressed Air.

1.4 SUBMITTALS

A. Shop Drawings.
   1. See Section 01332.
   2. Product Data: Submit manufacturer's product data, including surface preparation, application, curing, disinfection instructions, and material safety data sheets.
   3. Potable Water Certification: Submit certification that coating has been classified by an ANSI certified laboratory to ANSI/NSF 61 in reservoirs and joints.
   4. Applicator's Project References: Submit list of completed project references for applicator of potable water reservoir liners.

B. Samples: Submit 6 inch x 6 inch (150 mm x 150 mm) samples for approval by the Engineer.
   1. Cured membrane, 60 mils (1.5 mm) thick.
   2. Cured patching material.

C. Certification of Applicator's Supervisor: Submit for applicator's supervisor a certificate indicating completion of manufacturer's contractor training program.

D. Warranty: Submit warranty.

E. Maintenance Manual: Submit maintenance manual containing instructions for the Owner on how to properly maintain the waterproofing properties of the potable water reservoir liners.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Applicator: Use applicator experienced in the application of the specified potable water reservoir liners for a minimum of 5 years on projects of similar size and complexity. Provide list of completed projects including project name and location, name of engineer, name of coating manufacturer, and approximate quantity of liner applied.
2. Applicator's Supervisor: Employ a supervisor during all phases of the work who has successfully completed manufacturer's contractor training program.

3. Applicator's Personnel: Employ persons trained for the application of potable water reservoir liners.

B. Regulatory Requirements: Comply with environmental regulations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
   2. Do not deliver materials to site more than two weeks before use.

B. Storage:
   1. Store materials in accordance with manufacturer's instructions.
   2. Store materials indoors in an area well ventilated and protected from damage.
   3. Do not store materials near open flame, sparks, or hot surfaces.
   4. Store materials on raised platforms and covered by waterproof covers.
   5. Keep material containers closed.
   6. Keep a copy of the applicable material safety data sheets with each material.

C. Handling: Protect materials during handling and application to prevent damage.

1.7 WARRANTY

A. Provide a 5 year material and 1 year labor warranty. Obtain material warranty from manufacturer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable.
   1. C.I.M. Industries, Inc.

2.2 POTABLE WATER RESERVOIR LINERS

A. Liquid Membrane: CIM 1061 Commercial Industrial Membrane. Two-component, high solids, elastomeric asphalt extended, urethane industrial membrane. Designed for spray, squeegee, roller, or trowel application.
   1. Potable Water Service: Classified for potable water contact in reservoirs, pipes, and joints in accordance with ANSI/NSF 61.
      a. Maximum Use Level: 171²/L.
   2. Elastomeric Waterproofing, ASTM C 836 and C 957: Exceeds all criteria.
   4. Volatile Organic Compounds (VOC): 0.77 pounds per gallon (92 g/L).
5. Mullen Burst Strength, ASTM D 751, 50 mils (1.25 mm): Minimum 150 psi (1,034.2 kPa).
6. Tear Strength, ASTM D 624, Die C: 180 pounds per inch (31.5 N/mm).
7. Tensile Strength, ASTM D 412, 100-mil (2.5 mm) sheet: Minimum 1,000 psi (6,894.8 kPa).
9. Membrane Weight, 60 mils (1.5 mm) wet film thickness: 31 pounds per 100 square feet (1.51 kg/m2).
10. Recovery from 100 Percent Extension:
    a. After 5 Minutes: 98 percent.
    b. After 24 Hours: 100 percent.
11. Membrane Performance, Crack Bridging:
    a. 10 Cycles at -15 degrees F (-26 degrees C): Greater than 1/8 inch (3 mm).
    b. After Heat Aging: Greater than 1/4 inch (6 mm).
12. Membrane Performance, Weathering, ASTM D 832: 5000 hours.
15. Service Temperature: -60 to 220 degrees F (-50 to 105 degrees C).
17. Permeability to Water Vapor, ASTM E 96, Method E, 100 degrees F (38 degrees C), 100-mil (2.5 mm) sheet: 0.03 perms.
18. Abrasion Resistance, Weight Loss, ASTM D 4060: 1.2 mg.
19. Electrical Resistivity, Volume, ASTM D 257, 50 percent relative humidity, 23 degrees C, 2-inch (50 mm) disc, 100-mil (2.5 mm) thickness: 1.9 x 10E14 ohm-cm.
20. Adhesion to Concrete, Dry, Elcometer: 350 psi (2,413.2 kPa).

B. Primer: CIM 61 Epoxy Primer. Two-component, high solids, epoxy primer. Use as a prime coat on dry, porous and non-porous surfaces, such as concrete and steel. Prevents flash rust on blasted steel and minimizes outgassing from porous substrates. Ensures a continuous and uniform bond between surfaces.
1. Potable Water Service: Classified for potable water contact in reservoirs, pipes, and joints in accordance with ANSI/NSF 61.
3. Volatile Organic Compounds (VOC): 2.3 pounds per gallon (275 g/L).

C. Bonding Agent: CIM Bonding Agent. Organo-silane compound dispersed in isopropyl alcohol. Use as a solvent wash on non-porous surfaces, such as steel. Ensures a continuous and uniform bond between surfaces. Do not use where solvent cleaners are prohibited.
1. Potable Water Service: Classified for potable water contact in reservoirs, pipes, and joints in accordance with ANSI/NSF 61.
2. Solids by Volume: Less than 1 percent.
3. Volatile Organic Compounds (VOC): 6.4 pounds per gallon (743 g/L).

D. Patching Material: CIM 1000 Trowel Grade Commercial Industrial Membrane. Liquid applied, chemical and corrosion resistant urethane elastomer, chemically thickened to allow trowel applications with minimum sag. Use as a crack filler and for application to vertical surfaces and cold joints.
1. Potable Water Service: Classified for potable water contact in reservoirs, pipes, and joints in accordance with ANSI/NSF 61.
   a. Maximum Use Level: 171 cm²/L.
2. Elastomeric Waterproofing, ASTM C 836 and C 957: Exceeds all criteria.
4. Volatile Organic Compounds (VOC): 0.73 pounds per gallon (92 g/L).
5. Mullen Burst Strength, ASTM D 751, 50 mils (1.25 mm) in CIM Scrim: Minimum 150 psi (1,034.2 kPa).
6. Tear Strength, ASTM D 624, Die C: 150 pounds per inch (26.3 N/mm).
7. Tensile Strength, ASTM D 412, 100-mil (2.5 mm) sheet: Minimum 800 psi (5,515.8 kPa).
9. Membrane Weight, 60 mils (1.5 mm) wet film thickness: 31 pounds per 100 square feet (1.51 kg/m²).
10. Recovery from 100 Percent Extension:
    a. After 5 Minutes: 98 percent.
    b. After 24 Hours: 100 percent.
11. Membrane Performance, Crack Bridging:
    a. 10 Cycles at -15 degrees F (-26 degrees C): Greater than 1/8 inch (3 mm).
    b. After Heat Aging: Greater than 1/4 inch (6 mm).
15. Service Temperature: -60 to 220 degrees F (-50 to 105 degrees C).
17. Permeability to Water Vapor, ASTM E 96, Method E, 100 degrees F (38 degrees C), 100-mil (2.5 mm) sheet: 0.03 perms.
18. Abrasion Resistance, Weight Loss, ASTM D 4060: 1.2 mg.
19. Adhesion to Concrete, Dry, Elcometer: 350 psi (2,413.2 kPa).

1. Weight: 3 ounces per square yard (100 g/m²).
2. Tensile Strength, ASTM D 1682: 57.1 pounds (30 kg).
3. Elongation, ASTM D 1682: 61.65 percent.
5. Trapezoid Tear Strength, ASTM D 1117: 16.1 pounds (7.2 kg).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect substrate and adjacent areas where potable water reservoir liners will be applied. Notify the Engineer of conditions that would adversely affect the application or subsequent utilization of the liners. Do not proceed with application until unsatisfactory conditions are corrected.

3.2 PROTECTION AND APPLICATION ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent work and surrounding areas from contact with potable water reservoir liners.
B. Environmental requirements.
   1. Do not apply in wet weather or when rain is imminent.
   2. Do not apply when the surface may become wet within 4 hours after application.
   3. Apply when surface is minimum of 50 degrees F (10 degrees C) and minimum of 5 degrees F (3 degrees C) above dew point. Consult manufacturer for cold weather application instructions.
   4. Do not apply to porous substrates when substrate or ambient temperatures are rising.
   5. Do not apply to porous substrates when substrate is in direct sunlight.
   6. Do not apply over substrates that are frozen or contain frost.

3.3 SURFACE PREPARATION FOR CONCRETE RESERVOIRS

A. Prepare surfaces in accordance with manufacturer's instructions and as shown on drawings.
B. Provide clean, dry, and structurally sound concrete surfaces.
C. Provide broom finish or float finish to Class B tolerance.
D. Concrete Curing:
   1. Allow concrete to cure a minimum of 28 days.
   2. Do not apply curing compounds.
E. Condition Survey: Perform a condition survey of existing concrete in accordance with ACI 201.1R.
F. Abrasive Blasting:
   1. Prepare concrete surfaces to receive potable water reservoir liners by abrasive blasting.
2. Remove dirt, soil, grease, oil, paint, coatings, form release agents, curing compounds, laitance, loose material, unsound concrete, and other foreign materials that would inhibit performance of potable water reservoir liners in accordance with ASTM D 4258 and by abrasive blasting.

3. Obtain a firm, sound concrete surface in which bug holes are fully opened.

4. Remove sharp concrete edges and projections.

5. Perform abrasive blasting in accordance with ASTM D 4259.

6. Receive approval by Engineer of blasting media.

7. Maintain air supply for abrasive blasting free of oil and water in accordance with ASTM D 4285.

G. Repair concrete surface to be free of holes. Fully open bug holes before repair. Repair defects in the concrete surface, such as bug holes, air pockets, and honeycomb by filling and smoothing off with patching material, epoxy patching compound, or grout. Abrasive blast repaired surfaces.

H. Do not apply primer or potable water reservoir liner to concrete surface unless a moisture test in accordance with ASTM D 4263 indicates no capillary moisture is present.

I. Apply primer to concrete surface at 5 mils (125 microns) dry thickness.

J. Allow primer to cure in accordance with manufacturer's instructions before topcoating with the liquid membrane.

3.4 APPLICATION

A. Apply potable water reservoir liners in accordance with manufacturer's instructions.

B. Keep material containers tightly closed until ready for use.

C. Keep equipment, air supplies, and application surfaces absolutely dry.

D. Mix and apply when liquid membrane is above 60 degrees F (15 degrees C).

E. Do not use adulterants, thinners, or cutback solutions.

F. Blend and mix 2-component materials in accordance with manufacturer's instructions. Do not hand mix components.

G. Maintain air supply for material spray application free of oil and water in accordance with ASTM D 4285.

H. Apply liquid membrane directly to a clean and dry surface or to scrim.

I. Apply 6 to 12 inch (150 to 300 mm) wide strip of joint cover sheet over cracks over 1/8 inch (3 mm) wide, non-working joints, and edges. Center joint cover sheet over all joints and adhere by first applying a tack coat of liquid membrane.

J. Apply sufficient liquid membrane to achieve 60 mils (1.5 mm) dry film thickness for potable water immersion service.
K. Prepare for joint lines should rain or other conditions require work stoppage or extended delay. Install joint lines clean and straight. Install overlap 6 inches (150 mm) minimum to ensure an impervious joint. Severely abrade with wire brush or sandpaper and apply bonding agent to all areas to be recoated when more than 4 hours curing time has taken place.

L. Recoating:
   1. Recoat liquid membrane system within 4 hours to obtain maximum interlayer adhesion to build specified thickness.
   2. Immersion Service: Complete recoating within 4 hours, except at joint lines
   3. Non-Immersion Service: Severely abrade with wire brush or surface grinder, apply bonding agent, and recoat, if membrane has cured more than 4 hours.

3.5 CURING

A. Cure membrane in accordance with manufacturer's instructions.
B. Do not allow uncured membrane to come into contact with potable water.
C. Curing Time:
   1. Allow sufficient time for solvents to evaporate from the cured liner before placing into potable water service.
   2. Allow minimum solvent release time of 2 weeks at 60 degrees F (15 degrees C) for a 60-mil (1.5 mm) membrane. Other temperatures or thicknesses may require different solvent release times.
D. Receive approval of cured liner by Engineer before disinfection.

3.6 CLEANING

A. Remove and dispose of all temporary materials used to protect adjacent work and surrounding areas.
B. Immediately remove and clean liner materials from surfaces not intended to receive the materials.
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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.
   i. Gasket materials shall comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420 – References.
   j. 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.
   k. 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 A 53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
23. ASTM A 312/A312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
27. ASTM B 88, Specification for Seamless Copper Water Tube.
29. ASTM C 296, Specification for Asbestos-Cement Pressure Pipe.
35. ASTM D 2513, Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
38. ASTM D 3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
40. ASTM D 3262, Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
42. ASTM D 4101, Specification for Propylene Plastic Injection and Extrusion Materials.
43. ASTM F 441, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
44. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
45. AWWA C110, Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids.
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.
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.
4. Markers bearing the legends on the background colors specified in Section 09900, Painting, and shall be provided in the following letter heights:
Outside Pipe Diameter,\(^a\) (inches) & Letter Height, (inches) \\
Less than 1-1/2 & 1/2 \\
1-1/2 through 3 & 1-1/8 \\
Greater than 3 & 2-1/4 \\

\(^a\) Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni- and bi-directional arrows in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

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. Steel pipe shall have welded joints, flanged joints, or flexible or mechanical coupling connectors as specified in Section 15102, Steel Pipe. Tie rods connected to ears welded to the steel pipe shall be provided for restraint at all flexible coupling connectors.
   c. 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.
   d. Harnessed 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.
   e. 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.

3.2 PIPING IDENTIFICATION

A. Pipe Coding:
   1. After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with painted bonding and lettering as specified in Article 2.2, above. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 25-foot centers.
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. 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.

C. Chlorine Systems:
1. General: Chlorine systems comprise of chlorine, in gaseous and liquid phase, under positive and negative pressure. After cleaning, as specified in Paragraph 3.6.E., below, the system shall be pressure tested. Pressure gages, relief valves, automatic control valves, and other components which may be damaged or exceeded by test pressures shall be removed and openings shall be blocked off prior to testing. Do not attempt to repair leaks until all pressure has dissipated from the system. The system shall be repaired and retested, as necessary, until a successful test (zero leakage) is achieved.
   a. For evaporator-supplied systems, disconnect the vent from the discharge side of the pressure relief valve of each evaporator, plug the resultant opening, inspect and secure all joints, close all valves which discharge to atmosphere, and open all in-line valves. Open the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator to provide a through path around this valve. System piping shall then be tested to 150 psig. After testing, replace all equipment previously removed and close all in-line valves. Reconnect the vent line to the downstream side of the pressure relief valve of each evaporator and close the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator.
   b. Steel pipelines shall be hydrostatically tested. However, if drying after hydrostatic testing is impractical or cannot be accomplished, test steel lines with nitrogen gas or dry air providing, that all the necessary safety precautions to safeguard personnel and minimize the risk incurred when performing such a test at high pressures have been taken. All CPVC pipelines shall be hydrostatically tested. Testing CPVC lines with nitrogen or air is not permitted.
2. Hydrostatic Testing: Steel piping lines and CPVC solution lines hydrostatically tested shall be tested to 150 psig. CPVC vacuum lines shall be hydrostatically tested to 50 psig. After testing, all moisture absorbing gaskets and valve packing shall be replaced.
3. Drying: Chlorine piping systems shall be dried prior to placing in service. Even if water has not been purposely introduced into the system for hydrostatic testing or cleaning, drying is still required because moisture may enter the system from the atmosphere or other sources.
   a. For steel pipe, drying shall be accomplished by passing steam through the lines from the high end of the system until the lines are thoroughly heated. While steaming, allow condensate and foreign matter to drain out. The steam supply shall then be disconnected and all pockets and low spots in the line drained. While the line is still warm, dry oil-free air having a dew point of -40°F, or below, shall
be blown through the line until the exiting air dew point is the same as the supply air. Valves shall be fixed in the half-open position during drying. Valves removed temporarily from the system during drying operations must be free of moisture before being recoupled to the piping system.

b. Drying of CPVC pipe applies solely to vacuum lines and consists of draining and removing all water and moisture from the system. After draining the line, first "pig" the pipe to remove excess water. Then air dry the system in accordance with the requirements for steel pipe. CPVC pipe shall not be steamed.

4. Nitrogen or Air Pressure Testing: May use nitrogen gas or oil-free dry air to test steel lines. Testing consists of gradually introducing nitrogen gas or dry air up to 50 psig and maintaining this pressure while testing the line for leaks with soapy water. When the system is free from leaks at this pressure, the test pressure shall then be increased in increments of 50 psig up to a maximum of 150 psig. At each stepped increase in pressure, check for leaks and take corrective action as necessary. When the system is free from leaks at the final test pressure, the system shall then be depressurized, the test source disconnected, and the system capped to prevent the entrance of water.

a. For testing with nitrogen gas, use cylinders of dry high purity nitrogen gas, nitrogen handling cylinder mounted pressure regulator 0 to 300 psig, and necessary fittings and adapters to complete connection between the source and system header. Pressure regulator shall be self-relieving type, which vents to the atmosphere, and includes a throttling valve.

b. For testing with air, provide oil-free air with a relative humidity of zero. All fittings, adapters, and accessories, pressure regulator and throttling valve shall be suitable for pressure testing with air and rated for 300 psig service.

5. Service Gas Testing: Immediately after the chlorine system has been dried and pressure tested, the service gas shall be gradually introduced and the entire system tested for leaks. Time shall be allowed for the complete replacement of air from the piping with service gas.

a. Use a liquid ammonia solution or chlorine gas detector to detect for chlorine leaks. Spray the solution at the pipe connections and shall not squirt the liquid on the pipe or fittings. In the event leaks are detected in the piping or the equipment, they shall not be repaired until all gas has been purged from the line. The reaction of the two substances produces a dense white cloud. Upon completion of repairs, repeat the cleaning and drying process described in this Paragraph and in Paragraph 3.6.E., below, and retest the lines with service gas.

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. 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.

D. Chlorine Systems:
1. General: All portions of the system shall be cleaned free of oil and grease.
2. Steel Pipe: All pipe threads shall be washed clean and free from cutting oil. The inside of all pipe sections and fittings shall be cleaned of any pipe dope, oil and grease by drawing a cloth wetted with solvent through each assembly. Valves shall be dismantled, thoroughly cleaned with solvents, and repacked, if necessary. Cap or plug all open ends at the end of each day's Work.
   a. Use carbon tetrachloride or trichloroethylene. At all times exercise caution to minimize solvent exposure and shall be responsible for its proper handling and disposal. Solvents containing hydrocarbons or alcohols are unacceptable.
3. CPVC Pipe: All solution lines shall be cleaned using water only. Vacuum lines shall be cleaned with a detergent and water and thoroughly rinsed to remove all vestiges of detergent. All lines shall be further purged of water by passing a cleaning ball or swab through the lines as specified in Paragraph 3.6.A., above.
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.

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>3.41</td>
<td>19</td>
<td>CLS</td>
<td>Chlorine Solution</td>
<td>Chemical</td>
</tr>
</tbody>
</table>

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### 3.4.1 SYSTEM - 19

**Piping Symbol/Service:**
- CLS: Chlorine Solution/Sample Return
- HCL: Hydrochloric Acid
- NAOCL: Sodium Hypochlorite
- CAS: Caustic Soda
- VCEN: Centrate Vent
- SPD: Sump Pump Discharge (Area 80 only)

**Test Requirements:**
- **Medium:** Water: Refer to Paragraph 3.5.C., above.
- **Pressure:**
  - 200 psig for piping in trenches and containment areas.
  - 100 psig for other piping.
  - 140 psig for piping between the RW ejector located in the Reuse Water Load Center Building and the RW application point in Area 90.
- **Duration:** 120 minutes.

**Gasket Requirements:**
- **Flange:** N/A.
- **Push-on/Mech Cpl:** N/A.

**Exposed Pipe/Valves:**
- **All sizes**
  - **Pipe:** CPVC: Sch. 80. Refer to Section 15106, Thermoplastic Pipe.
  - **Conn:** Plain end, solvent weld, flanged for valves 3-inch and larger.
  - **Ftgs:** Refer to Section 15106, Thermoplastic Pipe.

**All sizes**
- **Valves:** Refer to Section 15113, Thermoplastic Valves, Operators and Appurtenances.

**Buried and Encased Pipe/Valves:**
- **All sizes**
  - **Pipe:** CPVC: Same as exposed.
  - **Conn:** Same as exposed.
  - **Ftgs:** Same as exposed.

**All sizes**
- **Valves:** Same as exposed with extension stem and valve box.

**Remarks:**
1. Refer to Drawings for pipe size and valve type.
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DIVISION 16
ELECTRICAL
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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.

C. General:
   1. Interpretation of Drawings:
      a. Dimensions shown on the Drawings that are related to equipment are based on the equipment of one manufacturer. Confirm the dimensions of the equipment furnished to the space allocated for that equipment.
      b. The Drawings show the principal elements of the electrical Work. They are not intended as detailed working drawings for the electrical Work, but as a complement to the Specifications to clarify the principal features of the electrical systems.
      c. It is the intent of the Drawings and Specifications that all equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of
whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
d. It also is the intent of the Contract Documents that similar products are provided by the same manufacturer for uniformity on the Project.

D. Temporary Power and Lighting:
1. Refer to Section 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.

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.

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).
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 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 is Section 1.9, unless otherwise specified or noted on the Drawings.
   Proved the following types of enclosures:
   1. NEMA 3R, 4 or 12
   2. Corrosive Locations, NEMA 4X
C. Provide the following enclosure features:
   1. NEMA 3R, 4 or 12 Enclosures:
      a. Fabricate enclosures using minimum 14 gage steel for wall or frame mounted enclosures and minimum 12 gage for free standing enclosures. Keep steel free of pitting and surface blemishes.
      b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
      c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
      d. Provide control panel with flatness within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Verify flatness by using a 72-inch long straight edge. Limit out-of-flatness to gradual and in one direction only with no obvious depressions or wavy sections.
      e. Use pan type construction for doors. Door widths are not to exceed 36-inches.
      f. Mount doors with heavy duty hinge(s) with stainless steel hinge pins.
      g. Provide handle-operated, oil-tight, key-lockable three point stainless steel latching system with rollers on latch-rods for easy door closing.
      h. Product and Manufacturer: Provide one of the following:
         1) Hoffman
         2) Hammond
      i. Painting:
         1) Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Apply zinc phosphate for corrosion protection.
         2) Apply one coat of primer interior and exterior surfaces immediately after corrosion protection has been applied.
3) Coat exterior surfaces with primer surface applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.

4) Paint all exterior surfaces minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.

5) Provide compatible primer and finish paint with a low VOC, high solids polyurethane enamel. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.

6) Product and Manufacturer:
   a) Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin Williams, Inc
   b) Or equal.

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”x 12”x 6” fabricate using a minimum of 16 gage steel. Keep steel free of pitting and surface blemishes. Provide all surfaces with a smooth brushed finish.
   b. Provide stainless steel fast-operating clamp assemblies on three sides of each door.
   c. Rolled lip around three sides of door and along top of enclosure opening.
   d. Provide a hasp and staple for padlocking.
   e. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad for free-standing panel.
   f. Provide 5/16-inch diameter copper ground studs for the ground connection points for all panel equipment and panel doors.
   g. Product and Manufacturer: Provide one of the following:
      1) Hoffman
      2) Hammond

1.8 ELECTRICAL EQUIPMENT

A. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, with an ambient outside air temperature range of -10°F to 131°F and an elevation of 1227 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. Chlorine Building.

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.

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”.

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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.

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.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bare Ground Cable:
   1. Material: Annealed, bare, stranded copper.
   2. Product and Manufacturer: Provide ground cable of one of the following:
      a. Southwire Corporation.
      b. Service Wire Corporation.
      c. Encore Wire Company.

B. Ground Rods:
   1. Material: Copperclad rigid steel rods, 3/4-inch diameter, ten feet long.
   2. Manufacturer: Provide ground rods by one of the following:
C. Grounding Connectors:
1. Material: Pressure connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
2. Product and Manufacturer: Provide grounding connectors of one of the following:
   a. Pressure Connectors:
      1) O.Z./Gedney, Division of General Signal Corporation.
      2) Burndy Corporation.
   b. Welded Connections:
      1) Cadweld by Erico Products, Incorporated.
      2) Therm-O-Weld by Burndy Corporation.

D. Concrete Boxes:
1. Material: High density reinforced concrete box with non-settling shoulders positioned to maintain grade and facilitate back filling with steel checker plate screw down cover.
2. Size:
   a. Outside Locations: 15” x 22” minimum.
   b. Inside Locations: 10” x 17” minimum.
3. Product and Manufacturer: Provide box assembly from one of the following:
   a. Concrete Box:
      1) Christy Concrete Products, Inc. Model #B1017.
      2) Or Equal.
   b. Steel Cover:
      1) Christy Concrete Products, Inc. Model #B61JH labeled “GROUND”.
      2) Or Equal.

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING

A. Ground all electrical equipment in compliance with the National Electrical Code and the City of Phoenix Electrical Code.

B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where necessary for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.
C. Panel Grounding:
   1. A minimum size of 4/0 AWG bare stranded copper cable shall be installed between
      the ground grid and the panel enclosure grounding lug. The mounting frame for
      panels shall be grounded to the ground grid.
   2. A minimum size of 6 AWG insulated green stranded copper cable shall be installed
      between the ground grid and the isolated DC Ground Bus located on the enclosure
      sub-panel. This ground shall be installed in all panels that provide an isolated DC
      Ground Bus.

D. A separate green insulated ground conductor sized per conduit schedule as shown on
   DRAWINGS or NEC requirements shall be pulled into conduits and connected utilizing
   grounding conduit bushings.

E. Connect ground cable to piping by welding or brazing. Use copper bonding jumpers on
   all gasketed joints.

F. Connect ground cable to equipment by means of lug compressed on cable end. Bolt lug
   to equipment frame using holes or terminals provided on equipment specifically for
   grounding. Do not install with hold down bolts. Where grounding provisions are not
   included, drill suitable holes in locations designated by ENGINEER.

G. Connect to motors by bolting directly to motor frames, not to sole plates or supporting
   structures.

H. Connect to service water piping by means of copper clamps. Use copper bonding
   jumpers on gasketed joints.

I. Scrape bolted surfaces clean and coat with a conductive oxide-resistant compound.

J. Test all system grounding conductors for continuity of connection and electrical
   equipment. Provide in the final report a statement on equipment that was tested and
   document any discrepancies noted during the tests.

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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 cables.
   2. The types of cable include the following:
      a. Single Conductor Control Cable
      b. Shielded Cable

1.2 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for instrumentation cable proposed for use.

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. Multipaired Shielded Cable:
   1. To be utilized only for wiring between Remote Terminal Units and Intermediate Terminal Panels as shown on drawings.
   2. Bare, soft annealed copper, seven strand, tinned copper conductors, PVC insulated conductors, No. 16 AWG minimum, twisted in pairs with aluminum-mylar shield over each pair, tray cable rated, silicone rubber
fiberglass fire barrier tape, tinned copper drain wire, pairs shall be individually numbered, aluminum mylar overall shield, PVC outer jacket. Color shall be black and red. Rated for 600 volts. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.

3. Product and Manufacturer: Provide one of the following:
   a. Belden, No. 1043B.
   b. Or equal.

D. 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.

E. Cable/Wire Markers:
   1. Provide only heat shrinkage type cable/wire identification, which shall be type-written.
   2. Wire number shall include the conduit number and be a consecutive number based on the number of wires in a conduit, starting with number 1; example C18J – 1, where as C18J is the conduit number and 1 is the first wire. If ten wires are in a conduit, the numbering would be C18J-1 through C18J-10. No two wires are to have the same number.
   3. Product and Manufacturer: Provide the following:
      a. W.H. Brady Company. (Part # PSPT-187 for a single conductor)
      b. W.H. Brady Company. (Part # PSPT-500-1W for a twisted pair shielded cable)
      c. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Separation Requirements:
   1. Instrumentation Cables shall not be installed within the same conduits, raceways or cable trays with cables identified in Sections 16122, 16123 and 16124.
   2. 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. Install in conformance with the National Electrical Code and the City of Phoenix Electrical Code.

G. 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 witnessed 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.

++ 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 B 3, Soft or Annealed Copper Wire.
   2. ASTM B 8, 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 B 3 and B 8 with flame-retardant, moisture and heat resistant cross-linked polyethylene or thermoplastic insulation rated 90°C in dry locations and 75°C in wet locations and listed by UL as Type XHHW-2. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.
2. Application: Use Type XHHW-2 for all sizes, unless otherwise indicated.
3. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120 volt control circuits
4. Stranding: All 600 volt cable shall be stranded.
5. Product and Manufacturer: Provide one of the following:
   a. Okonite Company
   b. Encore Wire Corporation
   c. The Southwire Company
   d. Service Wire Company
   e. General Cable

B. Cable 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
   b. Burndy Hylug.
3. For wire sizes No. 4 AWG and above, use either compression type or bolted type with tinmed-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.

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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 45º or more.
      5) For non-encased underground conduit.

   b. Rigid Nonmetallic Conduit (RNC): Schedule 40 PVC conduit. (NEC Article 352)
      1) For concrete encased duct bank runs.

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 (ITP’s), pull boxes and penetrations in walls and floor slabs. Drawings of embedded conduits shall include cross-sections showing the thickness of the concrete slabs and the locations of conduits with respect to reinforcing steel and waterstops. Tag conduits per conduit schedule shown on drawings.
   4. Drawing shall be electronically produced to maintain quality and clarity of presentation when re-produced, even when reduced to half size (11” x 17”).
   5. Provide manufacturer’s proof of certification for PVC coated rigid metal conduit for all installer’s supervisors.

B. Record Drawings: Show the actual routing of exposed and concealed conduit runs on the Record Drawings conforming to the requirements of Section 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 ½” through 2”. Conduit or fittings having areas with thin or no coating shall be unacceptable. Do not use "LB" fittings for conduit sizes of 1¼” or larger. Use type "LBD" fittings wherever the use of fittings for conduit sizes of 1¼” or larger is unavoidable. All units shall be threaded type with five full threads. Material shall conform to ANSI C80.4.

   b. Use: Provide conduit fittings and outlet bodies in all corrosive locations.

   c. Manufacturer: Provide PVC coated conduit fittings and outlet bodies of one of the following:
      1) Robroy Industries, “Perma-Cote”.
      2) Robroy Industries, “Plasti-Bond”.
      3) OCAL Inc.

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 and direct cables, install warning ribbon approximately 12-inches below finished grade and centered on direct buried cables, electrical ductbanks and conduits without ductbank encasement. Provide 6-inch wide, 4-mil thickness underground metallic-lined marking tape with red polyethylene film on top and with clear polyethylene film on the bottom. The tape shall be permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".
   2. Manufacturers: Provide one of the following:
      a. Brady "Identoline"; Services and Materials "Buried Underground Tape"
      b. Somerset (Thomas & Betts) "Protect-A-Line"
PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in conformance of NEC, Articles 344, 352 and 358. Cap all conduits, ducts and raceways during construction to protect from debris entering and blocking the circuit installation.

B. Supports:
   1. Rigidly support conduits by clamps, hangers or strut channels.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers with Type 316 Stainless Steel horizontal members and Type 316 Stainless Steel threaded hanger rods, Kindorff or equal. Rods shall be not less than 3/8-inch diameter.
   3. PVC coated rigid metal conduit runs, beam clamps, U-bolts, pipe straps, clamp back spacers, clamp hangers and supports shall have a factory applied PVC coating or be stainless steel. Hardware shall be Type 316 Stainless Steel.
   4. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures by the following methods:
   1. To Wood: Type 316 Stainless Steel wood screws.
   2. To Hollow Masonry Units: Type 316 Stainless Steel toggle bolts.
   3. To Brick Masonry: Type 316 Stainless Steel Price expansion bolts, or equal.
   4. To Concrete: Refer to spec section 03252.
   5. To Steel: Type 316 stainless steel welded threaded studs, beam clamps or bolts with lock-washers or locknuts.

D. PVC Coated Rigid Metal Exposed Conduit:
   1. Install in strict accordance with manufacturer’s recommendations and installation manual. Installers shall be certified by the manufacturer before installation begins.
   2. Install with manufacturer’s installation tools and compounds to prevent damage to the PVC coating.
   3. Repair minor damage to interior urethane and exterior PVC coating with manufacturers recommended touch-up compound.
   4. Install parallel or perpendicular to structural members or walls.
   5. Wherever possible, run in groups. Provide conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at manufacturer’s recommended distances, or at every ten feet minimum.
   6. Install on structural members in protected locations.
   7. Locate clear of interferences.
   8. Maintain 6-inches from hot fluid lines and 1/4-inch from walls.
9. Install vertical runs plumb. Unsecured drop length not to exceed 12 feet.
10. Provide necessary reducers where equipment furnished cannot accept 3/4-inch conduit.

E. 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.

F. 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.

G. Field Bends: Use manufacturer supplied field bends whenever possible. No indentations. Diameter of conduit shall not vary more than 15 percent at any bend. Maximum total amount of bends shall not exceed 270°.
Length of run between manholes shall be limited to:
1. 300 feet with 270° in bends.
2. 600 feet with 180° in bends.
3. 1000 feet with 90° in bends.

H. 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.
I. 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 O-Z/Gedney.
      d. For conduits passing through existing interior concrete walls or floors and interior block walls, provide CSMC or CSMI type sealing bushings as manufactured by O-Z/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

J. 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

K. 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.

L. 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.

M. 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.
N. 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.

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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 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.
SECTION 16134

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install conduit expansion and deflection fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) current adoption.
   2. UL Standard 514, Electrical Outlet Boxes and Fittings.
   3. UL Standard 467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer’s catalog cuts and technical information for expansion and deflection fittings proposed for use.
   2. Listing of locations where fittings are to be installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast gray iron alloy or bronze end couplings, malleable iron or hot dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting to be watertight, corrosion-resistant UL listed and compatible with the conduit system.

B. Features:
   1. Expansion/Deflection Fittings.
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees.
      c. Parallel misalignment up to 3/4-inch.
   2. Expansion Fittings.
a. Expansion/Contraction, 8-inch total movement.

C. Product and Manufacturer: Provide one of the following:
   1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.
   2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
   3. Type DF for expansion/deflection or XJ for expansion only by Appleton Electric Company.
   4. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fittings in conformance with NEC.

B. Install expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Install expansion fittings on exposed conduit runs exceeding 200 feet.

C. Install expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Install fittings above waterstops.

D. In addition to as stated above, install expansion/deflection fittings as shown on CONTRACT DRAWINGS.

E. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid to PVC adapters for connection to fittings. Ensure that joints exposed to water are made watertight.

++ END OF SECTION ++
SECTION 16135

PULL BOXES

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 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.

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. For flush-mounted pullboxes in slabs or pavement, provide vehicular traffic-bearing covers, where shown on the Drawings.

5. Pull boxes embedded in concrete slabs shall be cast iron. Pull boxes located in wet, corrosive or outdoor areas shall be NEMA 4X, Type 316 stainless steel. All other areas shall be NEMA 12.

6. All boxes shall be identified in accordance with Section 16050, General Provisions.

7. All inside plant pull boxes used for communications, signal, or fiber optic cabling shall meet the requirements listed in table below:

<table>
<thead>
<tr>
<th>Maximum Trade Size of Conduit (inches)</th>
<th>Minimum Box Size (inches)</th>
<th>For Each Additional Conduit Increase Width (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width</td>
<td>Length</td>
</tr>
<tr>
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PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain a minimum of 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which they are mounted. Provide independent stainless steel or FRP supports where no walls or other structural surface exists. Do not locate pull boxes on handrails.

C. Install pull boxes where shown on the Drawings. In addition, install pull boxes in conduit runs containing more than three 90 degree bends and in runs exceeding 200 feet. For communications, signal, and fiber optic cabling conduit runs install
pull boxes in runs containing more than two 90 degree bends and in runs exceeding 100 feet.

D. Provide removable, flame-retardant, insulating cable supports in all boxes with any dimension exceeding three feet.

E. Field apply PVC touch up to scratched PVC boxes damaged as a result of installation. All touch up work shall be in strict conformance with manufacturer's recommendations and instructions.

F. Size pull boxes in accordance with the requirements of the Phoenix Electrical Code.

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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.

C. 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 45° 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 90º elbows, RNC risers and bell ends.

I. Reinforce all duct banks.
   1. Unless otherwise shown on the Drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 18-inches on centers, and No. 3 tie-bars transversely placed at 18-inch maximum longitudinal intervals. Overlap of No. 3 tie-bars shall be a minimum of 4-inches.
   2. Maintain a maximum clearance of 1-inch from bars to the edge of the concrete encasement.
   3. Install dowel reinforcement rebar where duct bank meets other concrete structures.

J. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.

K. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.

L. Install a bare stranded copper duct bank ground cable (4/0 or as shown on drawings) in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground cable to building and station ground grid or to equipment ground buses. In addition, connect ground cable to steel conduit extensions of the underground duct system. Provide ground clamp and bonding of each steel conduit extension, where necessary to maintain continuity of the ground system. Terminate ground cable at last manhole or handhole for outlying structures.

M. After completion of the duct bank or utilizing existing ducts and prior to pulling cable, pull a mandrel, not less than 12-inches long and with a cross section approximately 1/4-inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.

N. Pulling Rope/Tape
1. Pulling rope or tape shall be constructed of polyester and factory lubricated. Nylon is not allowed.

O. Warning Ribbon:
   1. Provide as stated in Specification Section 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 ++
DIVISION 17

INSTRUMENTATION AND
CONTROLS
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SECTION 17001

PROCESS CONTROL SYSTEM
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. 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.

B. 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).

C. 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.

D. All control loops shall function as described in Section 17051, Process Control Descriptions or other Divisions and Drawings of the CONTRACT DOCUMENTS.

E. All instruments shall be field calibrated and witnessed by the ENGINEER as stated in Specification 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 water treatment processes and control philosophy in accordance with standard practices of the water 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 01320 – Progress Schedule 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&ID’s, Process Drawings, Electrical Drawings, Installation Details, etc,) and develop a list of concerns or problems noted for the completion of the complete operating PCS. Submit list to the ENGINEER prior to review of equipment submittals.

b. Coordinate and review all PCS submittals and related equipment submittals in accordance with the CONTRACT DOCUMENTS, prior to submission of submittal to the ENGINEER. Complete Submittal Transmittal Form 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 (MOPO’s) 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.
k. SAMA, Scientific Apparatus Manufacturers Association.
m. IEEE, Institute of Electrical and Electronic Engineers.
n. NEC, National Electrical Code.
o. FM, Factory Mutual.

1.3 COORDINATION AND PROGRESS MEETINGS

A. Schedule and coordinate the system installation with regard to all other Work on the site and in accordance with the provisions of the General Conditions. Said coordination shall be documented on the Project Schedule.

B. PCS coordination and progress meetings will be scheduled by the PCS COORDINATOR. The CONTRACTOR, ENGINEER, OWNER and appropriate EQUIPMENT SUPPLIERS shall be required to attend meetings during the time of active work on the PCS. A representative of the CCS VENDOR shall be required to attend meetings during the time of active work on the CCS. PCS COORDINATOR shall provide meeting minutes and updates to the project schedule.
   1. The purpose of the meetings shall be to review the progress of the Work involving the PCS and provide coordination for installation, testing, commissioning, and training of the equipment to ensure that the Project Schedule is met.
   2. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit CONTRACTOR to agreed procedures and schedules.

1.4 SUBMITTALS

A. Shop Drawings:
   1. General:
      a. Shop Drawing submittals are to be in accordance with the requirements of the CONTRACT DOCUMENTS and shall
conform to the requirements of Section 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

   d. Submit certificate of compliance with NSF/ANSI 61 Standard or with Arizona Administrative Code R18-4-213, in accordance with Section 01600 requirements, for all materials or products which can contact drinking water as part of a water treatment process or water supply system.

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. Submit 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 water 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 be 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 incidental 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.
   e. 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. 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 1 hour 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 1 hour 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.
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) or Motor Control Panel (MCP). If there is no LCP or MCP, loop power shall be derived from the Computer Control System - Remote Input/Output Panels (RIO)

2. Discrete Signals:
   a. Discrete signals for all field wires shall be designed to be fail safe.
      1) If a field wire for a control circuit device fails the equipment should be designed to shut down.
      2) If a field wire for an alarm circuit fails, the alarm shall be activated.

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 Reservoir No. 3

A. General:
   1. Process and Instrumentation Diagram: I-03.
B. Overview:
1. The existing level transducer/transmitters will be replaced with new level transducers/transmitters. The existing signals in the PCS will remain.
2. New intrusion alarms will be installed and alarmed at the PCS. The existing signal in the PCS will remain.

C. Monitoring and Control:
1. Field Instrumentation and Controls:
   a. LE/LIT-01, -02: Ultrasonic level transmitter.
   b. ZS-01, -02, -03, -04, -05, -06: Limit switches to alarm on intrusion for the level transducer openings, hatches and door.
2. Motor/Local Control Panel - Controls:
   a. None.
3. Computer Control System - Controls:
   a. None.
4. Equipment Set Points / Ranges

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<th>Device</th>
<th>Set Point / Range - Typical Value</th>
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<td>LIT-02</td>
<td>Range: 0-30 Feet</td>
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</tbody>
</table>

D. Interlocks:
1. N/A.

++ END OF SECTION ++
SECTION 17052

PROCESS CONTROL SYSTEM
PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust, commission and place into satisfactory operation all primary sensors and field instruments furnished under this Section.
   2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

B. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 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 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.

1.6 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 INSTRUMENTATION

INSTRUMENT TYPE L1 - LEVEL TRANSMITTER – ULTRASONIC TYPE

A. Type: Non-contact system using transducer to convert electrical pulses from the transmitter into sonic pulses directed towards the metered surface and receives the reflected sonic pulses and converts them back into electrical pulses for reception by the transmitter. Transmitter shall generate and time the electrical pulses, and count and convert the pulse travel times into an analog output signal linearly proportional to level/flow.

B. System Performance Requirements:
   1. Accuracy: Not less than ± 0.25 percent of full-scale range.
   2. Linearity and Repeatability: Not less than ±1 percent of full scale.
   3. Resolution shall be 0.1 percent of range of 2mm (0.08”) whichever is
4. Minimum Operating Distance from Transducer (Deadband): 12-inches.
5. Beam Pattern: 12 degree conical, maximum.
6. Transmitter Outputs: Provide each of the following:
   a. 4 to 20 mADC, direct acting and isolated, signal proportional to level, into 0 to 750 ohms.
   b. Minimum of six (6) independently adjustable alarm setpoint, relays outputs rated at five amps, 250 VAC non-inductive.
7. Environmental Conditions: Suitable for use under the environmental conditions specified in Section 17001, Process Control System General Requirements for Process Instrumentation.

C. Required Features:
1. Transducer:
   a. Encapsulated by a corrosion resistant and submergence resistant material: PVDF.
   b. Equipped with ANSI 150 pound flanges for flange mounting.
   c. 1-inch external NPT PVC coated galvanized rigid steel conduit connection.
2. Transmitter:
   a. Solid state construction.
   b. Built-in digital filtering for EMI protection and external acoustical noise rejection.
   c. Built-in automatic compensation for variations in temperature, pressure and density of the sonic signal medium.
   d. LCD indicator scaled in engineering units for the range required.
   e. Software adjustable zero and span adjustment over 0 to 100 percent of the calibrated range.
   f. Lost Echo and Power On Lights.
   g. Housed in weatherproof, splash proof and corrosion resistant NEMA 4X enclosure and suitable wall or pipe stand mounting. Provide with a transparent window to permit viewing indicating meter and lights.
   h. Internally mounted diagnostic LED’s to allow isolation of faults in terms of major components.
   i. Designed for operation on 120 VAC ±10 percent, 60 Hz power supply.
3. Accessories:
   a. Transducer cables 2-3 copper conductors, twisted with shield and drain wire, the actual length required, for connection between the transducer and transmitter
   b. One Hand held calibrator
D. Product and Manufacturer: Provide the following:
   1. Hydroranger 200 and ST-H transducer, as manufactured by Siemens.

**INSTRUMENT TYPE ZS1 – LIMIT SWITCH – MECHANICAL TYPE**

A. General: Limit switch provides signal indicating equipment has reached a preset position.

B. Required Features:
   1. Snap-action over center contact mechanism.
   2. Mechanically adjustable.
   3. Construction: NEMA 4X.
   4. Contact: DPDT 10A at 120VAC.

C. Product and Manufacturer: Provide one of the following:
   1. E50 Series, as manufactured by Cutler Hammer.
   2. Square “D” Company.

2.2 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: 20%.

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:
   a. 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:
   a. 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 1 hour for each type of the following instruments.
      1) L1
   b. Training shall accomplish the following:
      1) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance and equipment calibration.
CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir 1-ES2-3 Rehabilitation
PROJECT NUMBER: WS85050051

++ END OF SECTION ++
### INSTRUMENT INDEX

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<th>Spec. Inst. Type</th>
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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.
3. Coordinate serialized keys with the OWNER and complete the attached table.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++
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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. Coordinate serialized keys with the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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<th>M/C Inspector</th>
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DIGITAL INPUTS 1
DIGITAL OUTPUTS 0
ANALOG INPUTS 2
ANALOG OUTPUTS 0
TOTAL 3
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Introduction - Index Summary

This series of documents are to assist the development of an equipment setup, testing plans, and documentation binder; plus shows the level of detail requested by the Owner. These documents should help guide through the process and requirement but are 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. It is recommended to fully read this Index Summary prior to exploring the other documents. Throughout the WORD documents there are highlighted underlined link to blank forms in EXCEL format to assist development of the overall document. Also there are rough examples to the majority of section for better understanding the tasks.

Section 1: Overview
The overview is to give a general overview of the project, operation and testing goals. The narrative defines testing configurations highlighting temporary piping and connections. It is a general discussion how the testing will be preformed. Also, include startup team information and a Safety Program which focuses on Lockout/Tagout details.

Section 2: Test System Groups
Test System Groups identifies the groups of systems and sub-systems, the equipment and instrument involved in each test plan. The Test System Groups will be selected so that every component can be tested individually as sub-systems in a manor that duplicates, as closely as possible, the operating design. The grouping shall be based on the P&ID, which is the starting point to define each test groups.

Section 3: Supplier Equipment Setup, Calibration and Checkout
The goal of the Equipment Setup and Checkout is to verify to the Contractor, Subcontractors, and Suppliers all equipment and systems will function as designed.

Equipment Setup and Checkout consist of the equipment supplier or vendor checking, testing, debugging, and fine tuning of the new equipment/systems. This section will have instrument/equipment calibration log, system integration I/O list, manufacture/equipment specific testing, and manufactures Certificate of installation.

This section will also include Contractor checkout documentation such as Equipment and Instrumentation Checkout log which lists out all the specification or industry standard tests/checks required prior to startup of a piece of equipment, i.e. conduit mandraling, megger testing, and ground testing, etc.

Section 4: Contractor Testing
The goal of the Contractor Testing is for the Contractor, Subcontractors, and Suppliers to verify all equipment and systems will function as designed prior to Verification Testing with the Owner’s Representative or Owner’s staff. Prior to Contractor Testing all point-to-point verifications shall be completed independently by the Contractor and/or Subcontractors.

A Test Setup form shall be completed for each test group which tells how the system will be operated during testing. Defining test configurations, temporary connections, and bypass
connections. Test Setup form also informs everyone how much waste there will be and the approximate test duration plus shows who will be involved in the testing to ensure all parties are present. Lastly, the form can be utilized to detail why a scenario or equipment cannot be tested due to process demands or unattainable configurations.

The Contractor’s Functional Testing Plan when signed off by the Contractor shows every function, on each piece of equipment, operates properly and each piece of equipment operates as designed. The plan will clearly show every aspect of the system works in various conditions as described in the Control descriptions and detailed in the Process and Instrumentation drawings.

**Section 5: Verification Testing**
The Verification Testing goal is 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. **The Verification Testing can only start after all Equipment Setup and Checkout items are completed by the Contractor.** During the Verification Testing the Contractor, Subcontractors, Owner’s Representative, and Engineer will be involved. Since the instruments have been calibrated, the installation certified, and the I/O tested, it is expected that these plans will be similar but more compressed into systems and sub-systems than the Contractors Functional testing.

**Section 6: Demonstration Test**
Demonstration Test is 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. **The Demonstration Testing can only start after all Verification Test groups are completed by the Contractor.** The Contractor and Subcontractors will perform the testing for the Owner Representative, Owner, and Engineer to witness.

**Section 7: Commissioning**
Commissioning is the sequential process in which a newly constructed facility is put into successful operation, refer to specification section 01810. The goal is to allow the completed system to operate, over a specified time period, as designed with no deficiencies when intergraded into the Owner’s system. **The Commissioning can only start after all Demonstration Tests are completed by the Contractor.**

**Section 8: Schedule**
The schedule will be a detailed logic driven schedule defining activity dates and durations. Key items to be included in the Schedule: Startup meeting #1 at 35 percent of contract amount, meeting #2 at 50 percent of contract amount, meeting #3 at no later then 5 weeks prior to testing, final Startup plan package submission, final O&M manual submission, training, Verification testing, Demonstration testing, and Commissioning.

**Appendix**
Definitions plus all other documents pertinent to the equipment and system testing.
Binder Format:

A. Prepare data in the format detailed in the forms provided; forms shall be modified with project specific details.

B. 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. When multiple binders are used, correlate data into related consistent groupings.

C. 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.

D. 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.

E. 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.

F. 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.
Testing Flow Chart

1. Factory Testing
2. Delivery and Installation
3. Contractor Testing
4. Verification Testing
5. Demonstration Testing
6. Commissioning

Development of Testing Plan
- Meeting #1: Held at 35% Complete
- Meeting #2: Held at 50% Complete
- Meeting #3: 5 Weeks Prior to Testing

- Manufacture Certificate of Installation
- Manufacture/Vendor Startup
- System Integration
- Calibration
- Point to Point & I/O Testing
- Individual Functional Testing

Pre Approved O&M's

Final Delivery of O&M’s, Spare parts, and Vendor Training

Engineer’s Operational Training
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2. Startup Team
3. Emergency Contact Information
4. Safety Program

Section 2: Test System Groups
1. Test Groups

Section 3: Supplier Equipment Setup, Calibration, and Checkout
1. Calibration Log
2. System Integration and I/O Checkout List
3. Manufacture/Equipment Specific Testing
4. Manufactures Certificate of Installations
5. Equipment and Instrumentation Checkout Log

Section 4: Contractor Testing
1. Contractor Testing Plan
2. Contractor Testing Plan Sign-off Sheet

Section 5: Verification Testing
1. Verification Test Setup
2. Verification Test Plan

Section 6: Demonstration Test
1. Demonstration Test Setup
2. Demonstration Test Plan

Section 7: Commissioning
1. Commissioning Setup
2. Commissioning Monitoring Forms

Section 8: Schedule
1. Schedule
2. Training Request Forms

Appendix
1. Definitions plus all other documents pertinent to the equipment and system testing.
Section 1 | Overview
Section 1: Overview

Details: The overview is to give a general overview of the project, operation and testing goals. The narrative defines testing configurations highlighting temporary piping and connections. It is a general discussion how the testing will be performed. Also, include Startup Team information and a Safety Program which focuses on Lockout/Tagout details.

Items to be included in the Overview section:

1. Narrative
2. Startup Team
3. Emergency Contact Information
4. Safety Program
Narrative

General
This site consists of five booster pumps and surge control system. There is an Operator Interface Terminal (OIT) associated with the Remote Terminal Unit (RTU) Programmable Logic Controller (PLC). The RTU PLC is part of the SCADA system.

Booster Pumps
Booster Pumps are used to increase the pressure in a system. The pump station has five pumps and has provisions for one future pump. Each pump shall be controlled by a PLC and also contain monitoring devices for temperature, flow, current, voltage and local/remote status.

In Automatic control Pump Stations shall run off of system pressure. The pressure is compared with setpoint values for specific conditions which shall determine the speed of the pump(s) running (were applicable), and shall also determine the number of pumps needed (were applicable) to achieve the desired pressure.

In RTU PLC Automatic mode, the booster pumps are started and stopped by the RTU PLC to maintain the distribution system pressure. The target pressure range is defined by the operator entered pressure setpoint and pressure setpoint deadband. When the distribution pressure drops below the pressure setpoint plus the deadband, then the assigned lead booster pump will start. The pump speed will vary via PID control in an attempt to maintain the pressure setpoint. If the pump speed reaches its maximum speed setpoint and the pressure is less than or equal to the pressure setpoint plus deadband, then its speed will be locked and the assigned lag pump will start. When a pump is added, its speed will be adjusted via PID control to maintain the pressure setpoint. Available pumps will be added, as necessary, in the order defined by a given sequence to maintain the pressure setpoint.

Surge Control System

A surge tank will be provided to minimize system surges in the distribution system. The level of water in the surge tank will be determined by water pressure and pressure of compressed air. The water level shall be controlled with a defined range based on extracted high and low water levels from each level transmitter input signal.

High water level shall require intervention of the compressed air system. A high water level in either surge tank shall start the corresponding air compressor to add air to the tank; thus reducing the water level. Once the water level has reached the low level, the air compressor shall be automatically stopped through local surge tank system control panel hardwired logic.

An air compressor will be provided to maintain water level in the surge tank. The air compressor system will be provided with a locally mounted HAND-OFF-AUTOMATIC selector switch. An additional contact shall be wired as an input to the PLC for monitoring.
Testing
The pump will be operated in different control modes for purpose of demonstrating proper functioning of controls and obtaining run time on the equipment. The electrical system, the suction hydropneumatic tank, and site lighting systems will be on-line continuously during this test.

Notice
When the Contractor indicates that all Setup and Checkout testing is complete and with the written approval of Verification Testing can begin, Contractor will provide a minimum notice of five (5) working days in advance of testing.

Points of Connection
The booster station will be disinfected, flushed, and bacteriologically tested from the 16-inch Zone 4A Booster Station suction Point of Connection to temporary piping connected to the 16-inch booster station discharge, immediately upstream of the Zone 5EB Point of Connection. After bacteriological test results have been accepted, the booster station will be connected to the Zone 4A Point of Connection. The booster station will be operated during initial testing before being connected to the 16-inch Zone 5EB Point of Connection. If the booster station is found to operate properly, the booster station Zone 5EB Point of Connection will be completed for the remaining portion of the test. Valves in any City accepted distribution system will be used to isolate areas of the distribution system as needed. Only Water Services Department personnel will operate valves in the City accepted distribution system.

Demand
Fire hydrants will be utilized to provide demands for the water required during testing. See test outlines for details.

Objective of Test
The objective will be to operate the booster station with no failures during all test programs and during the commissioning period. Should there be any equipment failure during the test, a decision will be made as to whether the test should be stopped and program restarted, or if the test will continue where it was stopped.

Testing
The initial part of testing will be individual Contractor system testing. Then Owner Representative witness Verification testing. Next the Demonstration test with Owner. The last part of the testing program will last thirty (30) days of continuous service (commissioning).

Measurements and Readings
Measurements and readings will be taken during every change in operation, at a minimum of every two (2) hours, or as agreed upon by all participating parties.
# Startup Team

**Role:** Quality Control Manager  
Name: Jon Smith  
Company: Jon Contracting  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** General Contractor  
Name: Ron Smith  
Company: Jon Contracting  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Owner  
Name: Steve Smith  
Company: City of  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Construction Manager  
Name: Bob Smith  
Company: AA Consulting  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Inspector Electrical  
Name: Bob Smith  
Company: AA Consulting  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Electrical Specialist  
Name: Paul Smith  
Company: AA Electrical  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Mechanical Specialist  
Name: Paul Smith  
Company: AA Mechanical  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Instrumentation Specialist  
Name: Paul Smith  
Company: AA Electrical  
Contact Information: Cell: 555-555-5555 Email: aaa@.com

**Role:** Programming Specialist  
Name: Randy Smith  
Company: AA Electrical  
Contact Information: Cell: 555-555-5555 Email: aaa@.com
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.

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Company</th>
<th>Affiliation</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon Smith</td>
<td>Project Engineer, QC Manager</td>
<td>Jon Contracting</td>
<td>General Contractor</td>
<td>Cell: 555-555-5555 Email: <a href="mailto:aaa@.com">aaa@.com</a></td>
</tr>
<tr>
<td>Ron Smith</td>
<td>Project Manager</td>
<td>Jon Contracting</td>
<td>General Contractor</td>
<td>Cell: 555-555-5555 Email: <a href="mailto:aaa@.com">aaa@.com</a></td>
</tr>
<tr>
<td>Jack Smith</td>
<td>Foreman</td>
<td>Jon Contracting</td>
<td>General Contractor</td>
<td>Cell: 555-555-5555 Email: <a href="mailto:aaa@.com">aaa@.com</a></td>
</tr>
<tr>
<td>Steve Smith</td>
<td>Project Manager</td>
<td>AA Consulting</td>
<td>Consultant</td>
<td>Cell: 555-555-5555 Email: <a href="mailto:aaa@.com">aaa@.com</a></td>
</tr>
</tbody>
</table>
Safety Program
Section 2  |  Test System Groups
Section 2: Test System Groups

Details: Test System groups identify all systems and sub-systems, the equipment and instrument involved in each plan. The Test System Groups will be selected so that every component can be tested individually as sub-systems in a manor that duplicates, as closely as possible, the operating design. From these groups individual test plans will be developed for the Contractor self tests plus the Verification Testing. The grouping shall be based on the P&ID, which is the starting point to define each test groups. Following each test group, include the associated P&ID with the equipment, instrument, or signals involved in the test group highlighted.

Test System Groups Table

<table>
<thead>
<tr>
<th>Test Group</th>
<th>Description</th>
<th>P&amp;ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

Items to be included in the Test System Groups section:

1. Test Groups with Highlighted P&ID

**Add groups as needed**
## Test System Group

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Reference Drawing:</th>
<th>Sample, Arizona</th>
<th>E010 and E011</th>
</tr>
</thead>
</table>

### Test Group: A - Service Entrance Section

**System:** Electric Power Service Entrance Section SES 100 and Customer Power Metering Systems

<table>
<thead>
<tr>
<th>Electrical Equipment:</th>
<th>LP-02</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GEN 121</td>
</tr>
<tr>
<td></td>
<td>MCC 100</td>
</tr>
<tr>
<td></td>
<td>Transformer TX596411</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>PQM 100</td>
</tr>
<tr>
<td>Other:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**System:** Electric Power Service Entrance Section SES 101

<table>
<thead>
<tr>
<th>Electrical Equipment:</th>
<th>LP-01</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transformer TX596412</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>N/A</td>
</tr>
<tr>
<td>Other:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**System:** Electric Power Distribution System

<table>
<thead>
<tr>
<th>Electrical Equipment:</th>
<th>MCC 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GEN 121</td>
</tr>
<tr>
<td></td>
<td>LP-02</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>N/A</td>
</tr>
<tr>
<td>Other:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Applicable P&ID with Test Group Highlighted
### Test System Group

| Project: | Sample |
| Location: | Sample, Arizona |

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

<table>
<thead>
<tr>
<th>System:</th>
<th>Electric Power Supply and Associated Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Equipment:</td>
<td>N/A</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>JA 114</td>
</tr>
<tr>
<td></td>
<td>YC 102</td>
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<tr>
<td>Other:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System:</th>
<th>Panel Lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Equipment:</td>
<td>Lighting</td>
</tr>
<tr>
<td></td>
<td>Receptacle</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>N/A</td>
</tr>
<tr>
<td>Other:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System:</th>
<th>Uninterruptable Power Supply (UPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Equipment:</td>
<td>N/A</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>Input and Outputs</td>
</tr>
<tr>
<td>Other:</td>
<td>Indication lights</td>
</tr>
</tbody>
</table>
Applicable P&ID with Test Group Highlighted
# Test System Group

**Project:** Sample  
**Location:** Sample, Arizona  
**Reference Drawing:** I011 & 1012

## Test Group: C - Disinfection System PLC Panel PNL 201

**System:** *Electric Power Supply and Associated Alarms*

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP01-14,16</td>
<td>JA 100</td>
<td>N/A</td>
</tr>
<tr>
<td>LP01-9</td>
<td>JA 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JA 101</td>
<td></td>
</tr>
</tbody>
</table>

**System:** *Panel Lighting*

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>N/A</td>
<td>Indicator light</td>
</tr>
<tr>
<td>Receptacle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP02-8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**System:** *Uninterruptable Power Supply (UPS)*

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP02-8</td>
<td>Input and Outputs</td>
<td>Indication lights</td>
</tr>
<tr>
<td>System:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air Conditioner</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Electrical Equipment: | LP02-14, 16  
| Air conditioner |  
| Instrumentation: | Input and Outputs |  
| Other: | Indication lights |  
| System: | **Operator Interface Terminal (OIT)** |  
| Electrical Equipment: | N/A |  
| Instrumentation: | N/A |  
| Other: | OIT Screen Indication |  
| System: | **Programmable Logic Controller (PLC)** |  
| Electrical Equipment: | N/A |  
| Instrumentation: | Input and Outputs |  
| Other: | N/A |  

Applicable P&ID with Test Group Highlighted
## Test System Group

**Project:** Sample  
**Location:** Sample, Arizona

### System: Site Lighting

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP01-5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### System: Electrical Equipment Area Lighting

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP01-2</td>
<td>N/A</td>
<td>N/A</td>
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</table>

### System: Disinfection Building Lighting

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP01-6</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### System: Site Electrical Receptacles

<table>
<thead>
<tr>
<th>Electrical Equipment</th>
<th>Instrumentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptacles</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>System</td>
<td>Electrical Equipment</td>
<td>Instrumentation</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Electrical Equipment Area Electrical Receptacles</strong></td>
<td>Receptacles</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Disinfection Building Electrical Receptacles</strong></td>
<td>Receptacles</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Applicable P&ID with Test Group Highlighted
# Test System Group

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
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<tbody>
<tr>
<td>Location:</td>
<td>Sample, Arizona</td>
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</tbody>
</table>

## Test Group: E - Suction Hydropneumatic Tank T 140 and Air Compressor 1 C 140

### System: Air Compressor 1 C-140

<table>
<thead>
<tr>
<th>Electrical Equipment:</th>
<th>SV-140</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>STR-140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instrumentation:</th>
<th>LSL-140</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSH-140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other:</th>
<th>N/A</th>
</tr>
</thead>
</table>

### System: Suction Hydropneumatic Tank T 140

<table>
<thead>
<tr>
<th>Electrical Equipment:</th>
<th>SV-140</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PLN-115</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Instrumentation:</th>
<th>LSL-140</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSH-115</td>
</tr>
<tr>
<td></td>
<td>PIT-115</td>
</tr>
<tr>
<td></td>
<td>PSL-115</td>
</tr>
<tr>
<td></td>
<td>LSSL-140</td>
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<tr>
<td></td>
<td>LSHL-140</td>
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<tr>
<td></td>
<td>LSHH-140</td>
</tr>
<tr>
<td></td>
<td>LE-140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other:</th>
<th>P1-115</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P1-135</td>
</tr>
<tr>
<td></td>
<td>LI-140</td>
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</tbody>
</table>
Applicable P&ID with Test Group Highlighted
### Test System Group

#### Project: Sample

#### Reference Drawing: I008

#### Location: Sample, Arizona

<table>
<thead>
<tr>
<th>Test Group: F - Booster Pump P 101</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System:</strong> Booster Pump P 101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Electrical Equipment:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>STR-101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Instrumentation:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>PSH-101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Other:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check Valve 38883</td>
</tr>
<tr>
<td>PI-101</td>
</tr>
</tbody>
</table>
Applicable P&ID with Test Group Highlighted
Section 3  |  Equipment Setup and Checkout
Section 3: Supplier Equipment Setup, Calibration, and Checkout

**Details:** The goal of the Equipment Setup and Checkout is to verify to the Contractor, Subcontractors, and Suppliers all equipment and systems will function as designed.

Equipment Setup and Checkout consist of the equipment supplier or vendor checking, testing, debugging, and fine tuning of the new equipment/systems. This section will have instrument/equipment calibration log, system integration I/O list, manufacture/equipment specific testing, and manufactures Certificate of installation.

This section will also include Contractor checkout documentation such as Equipment and Instrumentation Checkout log which lists out all the specification or industry standard tests/checks required prior to startup of a piece of equipment, i.e. conduit mandraling, megger testing, individual calibration tests, and ground testing etc.

Also see specification section for testing, individual equipment, reference form additional documentation to be presented in this section.

**During this testing the Contractor, Subcontractors, and Equipment Supplier will be involved at a minimum. Owner and Owner Representative are not involved during this initial setup.**

**Items to be included in the Equipment Setup and Checkout section:**

1. Instrumentation Calibration Log (Attach individual Calibration Tests - Form 17001-B)
2. System Integration and I/O Checkout List (Spec Section 17226)
4. Manufactures Certificate of Installations (Spec Section 01331 – Form 01620-A)
5. Individual Unit of Responsibility (Spec Section 01331 – Form 01600-D)
6. Equipment and Instrumentation Checkout Log

**Note:** Not all documents are listed above, review individual equipment and testing specifications for possible additional requirements.
## Instrumentation Calibration Log

<table>
<thead>
<tr>
<th>Test Group</th>
<th>Drwg.</th>
<th>Tag No.</th>
<th>Type Description</th>
<th>Initials</th>
<th>Date</th>
<th>Initials</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>1005</td>
<td>PSH-140</td>
<td>Compressor High Pressure Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1005</td>
<td>PI-115</td>
<td>Hydropneumatic Tank Pressure Indicator</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1005</td>
<td>LSL-L-140</td>
<td>Low Low Level Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1005</td>
<td>LSHL-140</td>
<td>High Low Level Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1005</td>
<td>LSHH-140</td>
<td>High High Level Switch</td>
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<tr>
<td>E</td>
<td>1005</td>
<td>PI-135</td>
<td>Pressure Indicator</td>
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<tr>
<td>E</td>
<td>1005</td>
<td>PSH-115</td>
<td>High Pressure Switch</td>
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<tr>
<td>E</td>
<td>1005</td>
<td>PIT-115</td>
<td>Pressure Indicator Transmitter</td>
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<tr>
<td>E</td>
<td>1005</td>
<td>PSL-115</td>
<td>Low Pressure Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Form 17001-B

CALIBRATION TEST DATA FORM

Tag No. and Description: ________________________________________________
Make and Model No.:_________________________ Serial No.:_________________
Input:_____________________________ Output:_________________________

Scale:_____________________________ Range:__________________________

% of Range/ Display   Output
Set Point  Reading  Reading % Deviation  Calibration Basis

☐ Increasing ☐ Decreasing

Instrument Programming Parameters

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Parameter No.</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ___________________</td>
<td>____________</td>
<td>________________</td>
</tr>
<tr>
<td>2. ___________________</td>
<td>____________</td>
<td>________________</td>
</tr>
<tr>
<td>3. ___________________</td>
<td>____________</td>
<td>________________</td>
</tr>
<tr>
<td>4. ___________________</td>
<td>____________</td>
<td>________________</td>
</tr>
</tbody>
</table>

CERTIFIED ____________________________ Date _______________________

CONTRACTOR’S Representative

WITNESSED ____________________________ Date _______________________

OWNER’S Representative
# PROCESS CONTROL SYSTEM I/O LIST - COMPUTER CONTROL SYSTEM SPREADSHEET

<table>
<thead>
<tr>
<th>CCS Programmer</th>
<th>Const. Admin</th>
<th>Contractor</th>
<th>I&amp;C Inspector</th>
<th>P&amp;D Sheet No.</th>
<th>Service Description / Tag Extension</th>
<th>Serialized Key</th>
<th>I/O Type</th>
<th>Device Loop</th>
<th>FCU No.</th>
<th>FCU Digital Link</th>
<th>FCU Panel Name</th>
<th>Rack / Point Address</th>
<th>ID or Register Address</th>
<th>Existing Point?</th>
<th>Eng Units - Low (%)</th>
<th>Eng Units - High (%)</th>
<th>Eng Units</th>
<th>Alarm Setpoint</th>
<th>Alarm Priority</th>
<th>Comments</th>
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<td>BOOSTER STATION SUCTION PRESSURE</td>
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<td>AIR COMPRESSOR 1 AUTO STATUS</td>
<td>I005</td>
<td>YIA-140</td>
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<td>AIR COMPRESSOR 1 FAILURE ALARM</td>
<td>I005</td>
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<td>AIR COMPRESSOR 1 LOW LUBE OIL ALARM</td>
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<td>AIR COMPRESSOR 1 RUN STATUS</td>
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<td>BOOSTER PUMP 1 RUN STATUS</td>
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<td>BOOSTER PUMP 1 HAND STATUS</td>
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<td>BOOSTER PUMP 1 REMOTE STATUS</td>
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<td>BOOSTER PUMP 1 AUTO STATUS</td>
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<td>BOOSTER PUMP 1 MOTOR OVERLOAD ALARM</td>
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<td>BOOSTER PUMP 1 GENERAL FAULT ALARM</td>
<td>I008</td>
<td>YA-101A</td>
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</tr>
</tbody>
</table>

| DIGITAL INPUTS | - | - |
| DIGITAL OUTPUTS | - | - |

TOTAL: 0
Manufacture/Equipment/Specification
Specific Testing Documentation
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
Equipment and Instrumentation Checkout Log

<table>
<thead>
<tr>
<th>Test Group</th>
<th>Spec. Drwg.</th>
<th>Description</th>
<th>Checkout Complete per Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pressure test</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bac’t test</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electrical testing per specification 16000 and 17000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loop checks</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completed 16000-A: Equipment Information Form</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completed 16000-C: Equipment Supplier Form</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Completed 01600-B: Unit Responsibility Form</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power System Study approved</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent voltage warning signs installed on all mechanical equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Verify arc flash and voltage warning signs placed on all electrical and mechanical equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All mechanical equipment has been installed correctly and anchored.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment aligned properly with no stress or strain exerted on the equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Individual mechanical, electrical, HVAC, and instrumentation checks</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All tasks defined in specification 01751</td>
<td></td>
</tr>
</tbody>
</table>
Section 4  |  Contractor Testing
Section 4: Contractor Testing

Details: The goal of the Contractor Testing is for the Contractor, Subcontractors, and Suppliers to verify all equipment and systems will function as designed prior to Verification Testing with the Owner’s Representative or Owner's staff. Prior to Contractor Testing all point-to-point verifications shall be completed independently by the Contractor and/or Subcontractors.

A Test Setup form shall be completed for each test group which tells how the system will be operated during testing. Defining test configurations, temporary connections, and bypass connections. Test Setup form also informs every one how much waste there will be and the approximate test duration plus shows who will be involved in the testing to ensure all parties are present. Lastly, the form can be utilized to detail why a scenario or equipment cannot be tested due to process demands or unattainable configurations.

The Contractor’s Functional Testing Plan when signed off by the Contractor shows every function, on each piece of equipment, operates properly and each piece of equipment operates as designed. The plan will clearly show every aspect of the system works in various conditions as described in the Control descriptions and detailed in the Process and Instrumentation drawings.

**During this testing the Contractor, Subcontractors, and Equipment Supplier will be involved at a minimum. Owner and Owner Representative are not involved during this initial testing.

Items to be included in the Contractor Testing section:

1. Contractor Test Setup
2. Contractor Test Plan

Note: Not all documents are listed above, review individual equipment and testing specifications for possible additional requirements.
<table>
<thead>
<tr>
<th>Test Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project:</strong> Sample</td>
</tr>
<tr>
<td><strong>Test System Group:</strong> A - Service Entrance Section</td>
</tr>
<tr>
<td><strong>Detailed Test Configuration, temporary connections, and bypass:</strong></td>
</tr>
<tr>
<td>The testing of the Service entrance section and power distribution system doesn’t required any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components; (Hardware checkout).</td>
</tr>
<tr>
<td><strong>Est. Duration (hr):</strong> N/A</td>
</tr>
<tr>
<td><strong>System Limitation:</strong> All components can be tested.</td>
</tr>
</tbody>
</table>

### Required Personnel to Complete Testing:

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

**Prepared By:** Name and Company

**See the Test System Layout for a list of items being tested**
## Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Project: Sample</th>
<th>Equipment/System Name: Service Entrance Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Reference Drawing: E010 and E011</td>
</tr>
</tbody>
</table>

### Test Group: A - Service Entrance Section

<table>
<thead>
<tr>
<th>Associated Tasks</th>
<th>Description</th>
<th>Contractor</th>
<th>Witness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Power Metering Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Electric Power Service Entrance Section SES 101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Electric Power Distribution System</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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><strong>Pre-Test Checks</strong></td>
<td></td>
</tr>
</tbody>
</table>

1. All Contractor starting and placing equipment in operation and equipment and system startup and performance testing are to be complete prior to start of Final Operational Test.

2. Verification of calibration and pump capacities is to be complete prior to start of final operational testing.

3. Contractor shall ensure all valve open-close positions are correct prior to starting each test below.
<table>
<thead>
<tr>
<th>B</th>
<th>Electric Power Service Entrance Section SES 100 and Customer Power Metering Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OPEN all branch circuit breakers in Panel LP-02.</td>
</tr>
<tr>
<td>2</td>
<td>OPEN main breaker in Panel LP-02.</td>
</tr>
<tr>
<td>3</td>
<td>OPEN all branch circuit breakers in Standby Generator GEN 121 panel.</td>
</tr>
<tr>
<td>4</td>
<td>OPEN main circuit breaker at Standby Generator GEN 121.</td>
</tr>
<tr>
<td>5</td>
<td>OPEN submain circuit breakers in Motor Control Center MCC 100.</td>
</tr>
<tr>
<td>6</td>
<td>OPEN main circuit breaker in Motor Control Center MCC 100.</td>
</tr>
<tr>
<td>7</td>
<td>OPEN main circuit breaker in Service Entrance Section SES 100.</td>
</tr>
<tr>
<td>8</td>
<td>Energize APS transformer TX596411 (500 KVA, 277/480V).</td>
</tr>
<tr>
<td>9</td>
<td>CLOSE main circuit breaker in Service Entrance Section SES 100.</td>
</tr>
<tr>
<td>10</td>
<td>CLOSE main circuit breaker in Motor Control Center MCC 100.</td>
</tr>
<tr>
<td>11</td>
<td>CLOSE circuit breaker at MCC 100 for Panel LP-02.</td>
</tr>
<tr>
<td>12</td>
<td>CLOSE main circuit breaker in Panel LP-02.</td>
</tr>
<tr>
<td>13</td>
<td>CLOSE Circuit 6 breaker in Panel LP-02.</td>
</tr>
<tr>
<td>14</td>
<td>Read and document the following data using PQM 100 locally: peak demand real power, Vab, Vbc, Vca, average line voltage, voltage unbalance, A current, B power, average line voltage. Some data cannot be taken until major equipment is in operation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>Electric Power Service Entrance Section SES 101</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OPEN branch circuit breakers in Distribution Panel LP-01.</td>
</tr>
<tr>
<td>2</td>
<td>OPEN main circuit breaker in Service Entrance Section SES 101.</td>
</tr>
<tr>
<td>3</td>
<td>Energize APS transformer TX596412 (50 KVA, 120/240V).</td>
</tr>
<tr>
<td>4</td>
<td>CLOSE main circuit breaker in Service Entrance Section SES 101.</td>
</tr>
<tr>
<td>5</td>
<td>CLOSE all branch circuit breakers-with loads.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D</th>
<th>Electric Power Distribution System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CLOSE submain circuit breakers in Motor Control Center MCC 100.</td>
</tr>
<tr>
<td>2</td>
<td>CLOSE main circuit breaker at Standby Generator GEN 121.</td>
</tr>
<tr>
<td>3</td>
<td>CLOSE branch circuit breakers in Distribution Panel LP-02.</td>
</tr>
<tr>
<td>4</td>
<td>Confirm remaining correct operation during testing described in each section below.</td>
</tr>
</tbody>
</table>
**Test Setup**

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Location:</th>
<th>MCC</th>
</tr>
</thead>
</table>

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

Detailed Test Configuration, temporary connections, and bypass:

*The testing of the RTU and CCS system doesn’t required any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components; (Hardware checkout).*

**Est. Duration (hr):** N/A  **Est. Flow / Usage (mgd):** N/A

**System Limitation:** All components can be tested.

---

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By:** Name and Company

---

**See the Test System Layout for a list of items being tested**
## Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Contractor</th>
<th>Witness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Tasks</td>
<td>Description</td>
<td>Verified</td>
</tr>
<tr>
<td>A Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Electric Power Supply and Associated Alarms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Panel Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Uninterruptable Power Supply (UPS)</td>
<td></td>
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</tr>
</tbody>
</table>

**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 Checks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placing equipment in operation and equipment and system startup and performance testing are to be complete prior to start of Final Operational Test.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verification of calibration and pump capacities is to be complete prior to start of final operational testing.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-close positions are correct prior to starting each test below.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Electric Power Supply and Associated Alarms</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Confirm HSQ/RTU Power Fail Alarm (JA 114) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Confirm HSQ/RTU OKPermissive (YC 102) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>OPEN circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTUPanel</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Confirm HSQ/RTUPanel Power Fail Alarm (JA 114) is enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Confirm HSQ/RTU OKPermissive (YC 102) is enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
</tbody>
</table>
### Panel Lighting

1. Confirm proper functioning of internal HSQ/RTU panel lighting and receptacle.

### Uninterruptable Power Supply (UPS)

1. **CLOSE** circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTU Panel.
   - Confirm normal mode indicator is ON and not flashing and percentage of UPS load capacity is indicated.

2. Enable test button on UPS. Confirm that no alarm beeps or alarm indicator stays ON.

3. OPEN circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTU Panel.

4. Confirm battery mode indicator is ON and alarm beeps twice every two seconds.

5. Confirm all devices and input/output cards connected to UPS remain powered.

6. **CLOSE** circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTU Panel.
   - Confirm normal mode indicator is ON and not flashing and percentage of UPS load capacity is indicated.

7. **OPEN** circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTU Panel.

8. Digital and Analog Inputs and Outputs.

9. Confirm proper operation of HSQ/RTU Panel when performing tests for other systems.
## Test Setup

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Location:</th>
<th>MCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test System Group:</strong></td>
<td>C - Disinfection System PLC Panel PNL 201</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Detailed Test Configuration, temporary connections, and bypass:**

The testing of the PNL 201 system doesn’t require any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components, (Hardware checkout).

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>N/A</th>
<th>Est. Flow / Usage (mgd):</th>
<th>N/A</th>
</tr>
</thead>
</table>

**System Limitation:** *All components can be tested.*

---

### Required Personnel to Complete Testing:

General Contractor: 
Electrical Contractor: 
Programmer: 
Owner's Staff: 
Engineer: 

Construction Manager: 
Inspector: 
Safety Personnel: 
Mechanical Contractor: 
Quality Control Manager: 

Prepared By: **Name and Company**

---

**See the Test System Layout for a list of items being tested**
### Test Group: C - Disinfection System PLC Panel PNL 201

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Contractor</th>
<th>Witness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Description Verified Date Verified Comments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Electric Power Supply and Associated Alarms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Panel Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Uninterruptable Power Supply (UPS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Air Conditioner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F Operator Interface (OIT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G Programmable Logic Controller (PLC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 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 Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 All Contractor starting and plaining equipment in operation and equipment and system startup and performance testing are to be complete prior to start of Final Operational Test.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Verification of calibration and pump capacities is to be complete prior to start of final operational testing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Contractor shall ensure all valve open-close positions are correct prior to starting each test below.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Electric Power Supply and Associated Alarms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 CLOSE circuit breaker (LP01-14,16) in Lighting Panel LP 01 that supplies electric power to panel air conditioner.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 CLOSE circuit breaker (LP01-9) in Lighting Panel LP 01 that supplies electric power to LP 01 Power Fail Alarm (JSL 100).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 CLOSE circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to disinfection System Panel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Confirm LP 01 Power Fail Alarm (JSL 100) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Confirm Disinfection System Panel PNL 201 Power Fail Alarm (JSL 101) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 OPEN circuit breaker (LP01-9) in Lighting Panel LP 01.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Confirm LP 01 Power Fail Alarm (JSL 100) is enabled at HSQ/RTU and CCS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 OPEN circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to Disinfection System Panel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Confirm Disinfection System Panel PNL 201 Power Fail Alarm (JSL 101) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### C Panel Lighting
1. Confirm proper function of internal PNL 201 panel lighting and receptacle.

### D Uninterruptable Power Supply (UPS)
1. CLOSE circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to disinfection System Panel.
2. Confirm normal mode indicator is ON and not flashing and percentage of UPS load capacity is indicated.
3. Enable test button on UPS. Confirm that no alarm beeps or alarm indicator stays ON.
4. OPEN circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to Disinfection System Panel.
5. Confirm battery mode indicator is ON and alarm beeps twice every two seconds.
6. OPEN circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to Disinfection System Panel.
7. Confirm normal mode indicator is ON and not flashing and percentage of UPS load capacity is indicated.

### E Air Conditioner
1. OPEN circuit breaker (LPOJ-14,16) in Lighting Panel LP 01 that supplies electric power to panel air conditioner.
2. Confirm panel air conditioner will not run.
3. CLOSE circuit breaker (LPOJ-14,16) in Lighting Panel LP 01 that supplies electric power to panel air conditioner.
4. Confirm panel air conditioner runs automatically on and off.
5. Measure temperature inside panel within 5 seconds of turn air conditioner off.

### F Operator Interface (OIT)
1. Confirm each OIT process graphic screen.
2. Confirm specific alarms and monitoring data when performing tests for other systems.

### G Programmable Logic Controller (PLC)
1. Confirm proper operation of PLC when performing tests for other systems.

**The tasks will clearly show every aspect of the equipment/system in various operating conditions as designed.**
<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Location:</th>
<th>MCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test System Group:</strong></td>
<td><strong>D - Lighting System</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Detailed Test Configuration, temporary connections, and bypass:**

The testing of the lighting system doesn't required any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components, (Hardware checkout).

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>N/A</th>
<th>Est. Flow / Usage (mgd):</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Limitation:</td>
<td><em>All components can be tested.</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By: **

Name and Company

**See the Test System Layout for a list of items being tested**
## Contractor’s Functional Test Plan

### Project: Sample  
**Equipment/System Name:** Lighting System  
**Contractor:**  
**Reference Drawing:**

### Test Group: D - Lighting System

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

Note: 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><strong>Pre-Test Checks</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placind equipment in operation and equipment and system startup are to be complete prior to start of Function Test.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verification of calibration and pump capacities is to be complete prior to start of final operational testing.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td><strong>Site Lighting</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker (LP 01-5) in Lighting Panel LP 01 that supplies electric power to perimeter lights.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable switch adjacent to slide gate and verify all lights are ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch and verify all lights are OFF.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td><strong>Electrical Equipment Area Lighting</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker (LP 01-2) in Lighting Panel LP 01 that supplies electric power to Electrical Equipment Area lights.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable switch on shade canopy column and verify all lights are ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch and verify all lights are OFF.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Disinfection Building Lighting</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker (LP 01-6) in Lighting Panel LP 01 that supplies electric power to Disinfection Building lights.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable switch adjacent to door and verify all lights inside and outside are ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch and verify all lights are OFF.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E</th>
<th>Site Electrical Receptacles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CLOSE circuit breaker feeding receptacles and verify all receptacles are energized.</td>
</tr>
<tr>
<td></td>
<td>Disable site lighting switch and verify all receptacles are energized.</td>
</tr>
<tr>
<td></td>
<td>OPEN circuit breaker feeding receptacles and verify all receptacles are not energized.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F</th>
<th>Electrical Equipment Area Electrical Receptacles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CLOSE circuit breaker feeding receptacles and verify all receptacles are energized.</td>
</tr>
<tr>
<td></td>
<td>Disable switch on shade canopy column and verify all receptacles are energized.</td>
</tr>
<tr>
<td></td>
<td>OPEN circuit breaker feeding receptacles and verify all receptacles are not energized.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>G</th>
<th>Disinfection Building Electrical Receptacles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CLOSE circuit breaker feeding receptacles and verify all receptacles are energized.</td>
</tr>
<tr>
<td></td>
<td>Disable switch adjacent to door and verify all receptacles are energized.</td>
</tr>
<tr>
<td></td>
<td>OPEN circuit breaker feeding receptacles and verify all receptacles are not energized.</td>
</tr>
</tbody>
</table>
## Test Setup

<table>
<thead>
<tr>
<th>Project: Sample</th>
<th>Location: MCC and Pump P101</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test System Group:</strong></td>
<td><em>E - Suction Hydropneumatic Tank T-140 and Air Compressor 1 C-140</em></td>
</tr>
</tbody>
</table>

**Detailed Test Configuration, temporary connections, and bypass:** The hydropneumatic tank will initially be filled with water to about half of the tank, then pressure will be manually added from the compressor to get to pressure about 25psi. From there the pressure and level indicators can be verified. Then the probe well will be isolated and the water level changed to simulate conditions and verify control.

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>4 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Flow / Usage (gal):</td>
<td>2000 gal</td>
</tr>
</tbody>
</table>

**System Limitation:** All components can be tested.

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Mechanical Contractor:</td>
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<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By:** Name and Company

**See attached Test System Layout for a list of items being tested**
## Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td></td>
</tr>
<tr>
<td>Equipment/System Name:</td>
<td>Hydropneumatic Tank T-140</td>
</tr>
<tr>
<td>Reference Drawing:</td>
<td>I-005</td>
</tr>
</tbody>
</table>

### Test Group: E - Suction Hydropneumatic Tank T-140 and Air Compressor 1 C-140

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Contractor</th>
<th>Witness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Associated Tasks</strong></td>
<td>Description</td>
<td>Verified</td>
</tr>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>HAND OPERATION</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>High Air Pressure</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Motor Overload</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Low Lube Oil Level</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Suction Hydropneumatic Tank Water Level High High (LSHH #140)</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Low Booster Station Suction Pressure (PSL #115)- Local Reset</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Low Booster Station Suction Pressure (PSL #115)- CCS Reset</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>AUTOMATIC OPERATION</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>High Air Pressure</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Motor Overload</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Low Lube Oil Level</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Suction Hydropneumatic Tank Water Level High High (LSHH #140)</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Low Booster Station Suction Pressure (PSL #115)- Local Reset</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Low Booster Station Suction Pressure (PSL #115)- CCS Reset</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Test Plan:</th>
<th>Task Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task # A</td>
<td>Pre-Test Checks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placing equipment in operation and equipment and system startup are to be complete prior to start of Function Test.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verification of calibration and pump capacities is to be complete prior to start of final operational testing.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.</td>
<td></td>
</tr>
</tbody>
</table>
### B  HAND OPERATION

1. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is OFF at motor control center, MCC 100.
2. Enable all disconnects and circuit breakers that feed power to air compressor.
3. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
4. Confirm air compressor does not start.
5. Place Hand-Off-Auto (HOA) selector switch for air compressor in HAND at motor control center, MCC 100.
6. Enable START push button for air compressor at MCC 100.
7. Confirm air compressor starts.
8. Confirm solenoid valve SV -140 on air line to Suction Hydropneumatic Tank T 140 automatically opens.
9. Confirm local RUN indication (YIR 140) at MCC 100.
10. Confirm RUN indication (YIR 140) at HSQ/RTU and CCS.
11. Confirm local ETM (KI 140) increases at MCC 100.

### C  High Air Pressure

1. Close shutoff valve in air compressor discharge line at hydropneumatic tank.
2. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
3. Monitor pressure until pressure increases and reaches the high air pressure switch (PSH 140) setpoint pressure.
4. Confirm air compressor STOPS after time delay TDR1.
5. Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.
6. Confirm local HIGH air pressure alarm indication (fLA 140C) at MCC 100.
7. Confirm HIGH air pressure alarm indication (PAN 140) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
9. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
10. Enable START push button for air compressor at MCC 100.
11. Confirm air compressor does NOT start.
12. Open shutoff valve and clear high pressure air condition.
13. Enable local High Pressure alarm reset push button (HMS 140A) at MCC100.
14. Confirm local High Pressure alarm indication (YA 140C) is OFF at MCC100.
15. Confirm HIGH air pressure alarm indication (PAH 140) at HSQ/RTU automatically resets and is OFF.
16. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
17. Enable START push button for air compressor at MCC 100.
18. Confirm air compressor starts.
## Motor Overload

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Trip motor overload at MCC 100.
3. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
4. Enable START push button for air compressor at MCC 100.
5. Confirm air compressor does NOT start.
6. Confirm local Air Compressor 1 Failure alarm indication (YA 140B) at MCC 100.
7. Confirm Air Compressor 1 Failure alarm indication (YA 140B) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
10. Enable local Air Compressor 1 Failure alarm reset push button (BMS 140A) at MCC 100.
11. Confirm local Air Compressor 1 Failure alarm indication (YA 140C) is OFF at MCC 100.
12. Confirm Air Compressor 1 Failure alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.
13. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
14. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
15. Enable START push button for Air Compressor 1 at MCC 100 and confirm air compressor starts.

## Low Lube Oil Level

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Simulate a low lube oil level alarm.
3. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
4. Enable START push button for air compressor at MCC 100.
5. Confirm air compressor does NOT start.
6. Confirm local Air Compressor 1 Low Lube Oil Alarm indication (YA 140A) at MCC 100.
7. Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140A) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
10. Enable local Air Compressor 1 Low Lube Oil alarm, reset push button (HMS 140A) at MCC100.
11. Confirm local Air Compressor 1 Low Lube Oil alarm indication (YA 140A) is OFF at MCC 100.
12. Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.
13. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
14. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
15. Enable START push button for Air Compressor 1 at MCC 100 and confirm air compressor starts.
F  Suction Hydropneumatic Tank Water Level High High (LSHH #140)

- LSZH140. This will overcome the concern of allowing air out of hydropneumatic tank through the pressure relief valve.
- 2 Confirm Suction Hydropneumatic Tank Water Level High High alarm indication (LAHH 140) at HSQ/RTU and CCS.
- 3 Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
- 4 Enable START push button for air compressor at MCC 100.
- 5 Confirm air compressor starts.
- 6 Enable STOP push button for air compressor at MCC 100 to stop compressor.
- 7 Lower water level in suction hydropneumatic tank to below LSHH 140.
- Confirm Suction Hydropneumatic Tank Water Level High High alarm indication (LAHH 140) at HSQ/RTU and CCS automatically reset and are OFF.

G  Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)

- 1 Isolate the level probe bottle and lower water level in suction hydropneumatic tank probe bottle to reach LSLL 140.
- 2 Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication (LALL 140) at HSQ/RTU and CCS.
- 3 Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
- 4 Enable START push button for air compressor at MCC 100.
- 5 Confirm air compressor will NOT start.
- 6 Raise water level in suction hydropneumatic tank probe bottle to above LSZH140.
- Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication (LALL 140) at HSQ/RTU and CCS automatically reset and are OFF.
- 8 Enable START push button for air compressor at MCC 100.
- 9 Confirm air compressor starts.

I  Low Booster Station Suction Pressure (PSL #115)- CCS Reset

- 1 Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
- 2 Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
- 3 Enable START push button for air compressor at MCC 100.
- 4 Confirm air compressor starts.
- 5 Simulate Low Booster Station Suction Pressure (PSL 115) using block and bleed valve and/or test ports at Panel PNL-115.
- 6 Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
- 7 Confirm air compressor does NOT stop.
- 8 Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.
- 9 Enable local alarm reset push button at PNL 100 at MCC 100.
- 10 Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNL 100 at MCC 100.
- 11 Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.
### H Low Booster Station Suction Pressure (PSL #115)- Local Reset

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
3. Enable START push button for air compressor at MCC 100.
4. Confirm air compressor starts.
5. Simulate Low Booster Station Suction Pressure (PSL 115).
6. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
7. Confirm air compressor does NOT stop.
8. Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.
9. Enable CCS alarm reset push button.
10. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNL 100 at MCC 100.
11. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.

### J AUTOMATIC OPERATION

- Confirm Hand-Off-Auto (HOA) selector switch for air compressor is OFF at motor control center, MCC 100.
- Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
- Place Hand-Off-Auto (HOA) selector switch for air compressor in AUTO at motor control center, MCC 100.
- Confirm air compressor starts.
- Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.
- Confirm local RUN indication (YL 140) at MCC 100.
- Confirm RUN indication (YIR 140) at HSQ/RTU and CCS.
- Confirm local ETM (KI 140) increases at MCC 100.
<table>
<thead>
<tr>
<th>K</th>
<th>High Air Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Close shutoff valve in air compressor discharge line at hydropneumatic tank.</td>
</tr>
<tr>
<td>2</td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td>4</td>
<td>Confirm air compressor starts and then STOPS after time delay TDR1.</td>
</tr>
<tr>
<td>5</td>
<td>Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm local HIGH air pressure alarm indication (YA 140C) at MCC 100.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm HIGH air pressure alarm indication (PAR 140) at HSQ/RTU.</td>
</tr>
<tr>
<td>8</td>
<td>Confirm Air Compressor 1 General Trouble alarm indication at CCS.</td>
</tr>
<tr>
<td>9</td>
<td>Open shutoff valve and clear high pressure air condition.</td>
</tr>
<tr>
<td>10</td>
<td>Enable local High Pressure alarm reset push button (HMS 140A) at MCC 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm local High Pressure alarm indication (YA 140C) is OFF at MCC100.</td>
</tr>
<tr>
<td>12</td>
<td>Confirm HIGH air pressure alarm indication (PAR 140) at HSQ/RTU automatically resets and is OFF.</td>
</tr>
<tr>
<td>13</td>
<td>Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.</td>
</tr>
<tr>
<td>14</td>
<td>If necessary, raise water level in Suction Hydropneumatic Tank T 140 to above LSH140.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm air compressor starts.</td>
</tr>
<tr>
<td>16</td>
<td>Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L</th>
<th>Motor Overload</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td>2</td>
<td>Trip motor overload at MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td>4</td>
<td>Confirm air compressor does NOT start.</td>
</tr>
<tr>
<td>5</td>
<td>Confirm local Air Compressor 1 Failure alarm indication (YA 140B) at MCC 100.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm Air Compressor 1 Failure alarm indication (YA 140B) at HSQ/RTU.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm Air Compressor Failure alarm indication (YA 140B) at CCS.</td>
</tr>
<tr>
<td>8</td>
<td>Reset motor overload.</td>
</tr>
<tr>
<td>9</td>
<td>Enable local Air Compressor 1 Failure alarm reset push button (HMS 140A) at MCC 100.</td>
</tr>
<tr>
<td>10</td>
<td>Confirm local Air Compressor 1 Failure alarm indication (YA 140C) is OFF at MCC 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm Air Compressor 1 Failure alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.</td>
</tr>
<tr>
<td>12</td>
<td>Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.</td>
</tr>
<tr>
<td>13</td>
<td>Confirm air compressor starts.</td>
</tr>
</tbody>
</table>
### M  Low Lube Oil Level

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Simulate a low lube oil level alarm.
3. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
4. Confirm air compressor does NOT start.
5. Confirm local Air Compressor 1 Low Lube Oil alarm indication (YA 140A) at MCC 100.
6. Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140A) at HSQ/RTU.
7. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
8. Clear simulated low lube oil level condition.
9. Enable local Air Compressor 1 Low Lube Oil alarm reset push button - (HMS 140A) at MCC 100.
10. Confirm local Air Compressor 1 Low Lube Oil alarm indication (YLA 140A) is OFF at MCC 100.
11. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
12. Confirm air compressor starts.

### N  Suction Hydropneumatic Tank Water Level High High (LSHH #140)

- Raise water level in Suction Hydropneumatic Tank T 140 to above LSHH 140. This could allow air out of hydropneumatic tank.
- Confirm Suction Hydropneumatic Tank Water Level High High alarm indication (LAHH 140) at HSQ/RTU and CCS automatically reset and are OFF.
- Confirm Suction Hydropneumatic Tank Water Level High High alarm indication at HSQ/RTU and CCS automatically reset and are OFF.

### O  Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)

- Lower water level in suction hydropneumatic tank to below LSLL 140.
- Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication (LALL 140) at HSQ/RTU and CCS automatically reset and are OFF.
- Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication at HSQ/RTU and CCS automatically reset and are OFF.
- Confirm air compressor starts.
<table>
<thead>
<tr>
<th></th>
<th><strong>Low Booster Station Suction Pressure (PSL #115)- Local Reset</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td></td>
<td>2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td></td>
<td>3. Confirm air compressor starts.</td>
</tr>
<tr>
<td></td>
<td>4. Simulate Low Booster Station Suction Pressure (PSL 115).</td>
</tr>
<tr>
<td></td>
<td>5. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td></td>
<td>6. Confirm air compressor stops.</td>
</tr>
<tr>
<td></td>
<td>7. Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.</td>
</tr>
<tr>
<td></td>
<td>8. Enable local alarm reset push button at PNL 100 at MCC 100.</td>
</tr>
<tr>
<td></td>
<td>9. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNL J00 at MCC J00.</td>
</tr>
<tr>
<td></td>
<td>10. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td></td>
<td>11. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td></td>
<td>12. Confirm air compressor starts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Low Booster Station Suction Pressure (PSL #115)- CCS Reset</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td></td>
<td>2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td></td>
<td>3. Confirm air compressor starts.</td>
</tr>
<tr>
<td></td>
<td>4. Simulate Low Booster Station Suction Pressure (PSL 115).</td>
</tr>
<tr>
<td></td>
<td>5. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td></td>
<td>6. Confirm air compressor stops.</td>
</tr>
</tbody>
</table>
## Test Setup

<table>
<thead>
<tr>
<th>Project: Sample</th>
<th>Location: MCC and Pump P101</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test System Group:</strong></td>
<td>F - Booster Pump P 101</td>
</tr>
</tbody>
</table>

### Detailed Test Configuration, temporary connections, and bypass:

1. 4" HDPE temporary piping will be run from the pump discharge header to the drainage area to the south of the site. The temporary piping will be connected at the 90 degree fitting just prior to the 4in PD going underground. The temporary piping will be routed south along the east fence and a small hole will be dug to go under the chain link fence and into the drainage area.

### Est. Duration (hr): 3 hours  
Est. Flow / Usage (mgd): 0.25

### System Limitation: A maximum of 1ft of discharge will be allow to develop during testing in the drainage area.

### Required Personnel to Complete Testing:

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By: Name and Company**

**See attached Test System Layout for a list of items being tested**
## Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Project: Sample</th>
<th>Equipment/System Name: Pump #101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Reference Drawing: I008</td>
</tr>
</tbody>
</table>

**Test Group: F - Booster Pump P 101**

<table>
<thead>
<tr>
<th>Associated Tasks</th>
<th>Description</th>
<th>Contractor</th>
<th>Witness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>HAND OPERATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Motor Overload (Motor Starter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Motor Overload (Motor Saver)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>High Pump Discharge Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Low Station Suction Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Low Station Discharge Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>High Station Discharge Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>High Station Suction Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>AUTO (PRESSURE SWITCH CONTROL) OPERATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>High Pump Discharge Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Low Station Suction Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Low Station Discharge Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>High Station Discharge Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>High Station Suction Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>REMOTE (HSQ/RTU CCS CONTROL) OPERATION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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><strong>A</strong> Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placing equipment in operation and equipment and system startup are to be complete prior to start of Function Test.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verification of calibration and pump capacities is to be complete prior to start of final operational testing.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-close positions are correct prior to starting each test below.</td>
<td></td>
</tr>
<tr>
<td><strong>B</strong> HAND OPERATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Confirm Hand-Off-Auto-Remote (HOAR) selector switch for all booster pumps are in OFF at motor control center, MCC 100.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Enable all disconnects and circuit breakers that feed power to Booster Pump P101.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Confirm Booster Pump P101 does not start.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flow rate that keeps Booster Pump P101 running.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Place Booster Pump P101 HOAR selector switch in HAND (Local Manual) at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Confirm HAND position status indication (YLA 101B) at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Enable START push button for Booster Pump P101 at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Confirm Booster Pump P101 starts.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Confirm local RUN indication (YL 101) at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Confirm local ETM (KI 101) increases at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Confirm local motor amperage indication (II 101) for each phase at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Enable STOP push button for Booster Pump P101 at MCC 100 and confirm pump STOPS.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Place Booster Pump P101 HOAR selector switch in OFF (Local Manual) at MCC 100.</td>
<td></td>
</tr>
<tr>
<td><strong>C</strong> Motor Overload (Motor Starter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Simulate motor overload at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Place Booster Pump P101 HOAR selector switch in HAND (Local Manual) at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Enable START push button for Booster Pump P101 at MCC 100 and confirm pump does not START.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Confirm local motor overload alarm indication (YA 101B) at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Confirm Booster Pump P101 motor overload alarm indication (YA 101B) at HSQ/RTU.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Confirm Booster Pump P101 motor overload alarm indication at CCS.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Enable motor overload reset for Booster Pump P101 at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Enable START push button for Booster Pump P101 at MCC 100 and confirm pump starts.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Confirm Booster Pump P101 motor overload alarm indications at HSQ/RTU and CCS are OFF.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Enable STOP push button for Booster Pump P101 at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>D Motor Overload (Motor Saver)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>1. Simulate high motor current at MCC 100.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Place Booster Pump P 101 HOAR selector switch in HAND (Local Manual) at MCC 100.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump does not START.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Confirm no local motor overload alarm indication (YLA 101B) at MCC 100.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Confirm no Booster Pump P-101 motor overload alarm indication (YLA 101B) at HSQ/RTU.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Confirm no Booster Pump P-101 General Trouble alarm indication at CCS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Clear high motor current condition at MCC 100.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Enable START pushbutton for Booster Pump P 101 at MCC 100 after time delay 0/motor saver and confirm pump STARTS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Enable STOP pushbutton for Booster Pump P 101 at MCC 100.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E High Pump Discharge Pressure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Partially CLOSE Booster Pump P 101 isolation valve (0038864).</td>
<td></td>
</tr>
<tr>
<td>2. Monitor pressure indicator PI 101 and record time when pressure increases and reaches the high pump discharge pressure switch (PSH 101) setpoint pressure. Note: For testing purposes adjust PSH 101 set point so that pump does not reach shutoff head.</td>
<td></td>
</tr>
<tr>
<td>3. Enable START pushbutton for Booster Pump P 101 at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>5. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>6. Confirm Booster Pump P 101 HIGH pump discharge pressure alarm (YA 101A) at HSQ/RTU.</td>
<td></td>
</tr>
<tr>
<td>7. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS.</td>
<td></td>
</tr>
<tr>
<td>8. OPEN Booster Pump P 101 isolation valve (0038864).</td>
<td></td>
</tr>
<tr>
<td>9. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pUmp does not start.</td>
<td></td>
</tr>
<tr>
<td>10. Enable local alarm reset pushbutton (HMS 101C) for Booster Pump P 101 at MCC 100.</td>
<td></td>
</tr>
<tr>
<td>11. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump starts.</td>
<td></td>
</tr>
<tr>
<td>12. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100 is OFF.</td>
<td></td>
</tr>
<tr>
<td>13. Confirm Booster Pump P 101 High Pump Discharge Pressure alarm (YA 101A) at HSQ/RTU is OFF.</td>
<td></td>
</tr>
<tr>
<td>14. Confirm Booster Pump P 101 General Trouble alarm at CCS is OFF.</td>
<td></td>
</tr>
<tr>
<td>15. Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low Station Suction Pressure</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.</td>
</tr>
<tr>
<td>2</td>
<td>Simulate Low Booster Station Suction Pressure (PSL 115). Monitor pressure indicator PI 135 to be below the low station suction pressure switch (PSL 115) setpoint.</td>
</tr>
<tr>
<td>3</td>
<td>Enable START pushbutton for Booster Pump P 101 at MCC 100 and confirm Booster Pump P 101 STARTS and does NOT STOP.</td>
</tr>
<tr>
<td>4</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.</td>
</tr>
<tr>
<td>5</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>6</td>
<td>Simulate Low Booster Station Suction Pressure (PSL 115). Monitor pressure indicator PI 135 to be above the low station suction pressure switch (PSL 115) setpoint.</td>
</tr>
<tr>
<td>7</td>
<td>Enable local Low Station Suction Pressure alarm reset pushbutton (HMS 115) at PNL 100.</td>
</tr>
<tr>
<td>8</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.</td>
</tr>
<tr>
<td>9</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.</td>
</tr>
<tr>
<td>10</td>
<td>Simulate Low Booster Station Suction Pressure (PSL 115). Monitor pressure indicator PI 135 to be below the low station suction pressure switch (PSL 115) setpoint.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm Booster Pump P 101 does NOT STOP.</td>
</tr>
<tr>
<td>12</td>
<td>Simulate Low Booster Station Suction Pressure (PSL 115). Monitor pressure indicator PI 135 to be above the low station suction pressure switch (PSL 115) setpoint.</td>
</tr>
<tr>
<td>13</td>
<td>Enable Low Station Suction Pressure alarm reset (YCR 115) at CCS.</td>
</tr>
<tr>
<td>14</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.</td>
</tr>
<tr>
<td>16</td>
<td>Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.</td>
</tr>
</tbody>
</table>
### G Low Station Discharge Pressure

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Place Booster Pump P 101 HOAR selector switch in HAND (Local Manual) at MCC 100.</td>
</tr>
<tr>
<td>2</td>
<td>Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump does START.</td>
</tr>
<tr>
<td>3</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that exceeds Booster Pump P 101 capacity and decreases pressure causing a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>4</td>
<td>Adjust PSL 150 setpoint if necessary. Confirm that Booster Pump P 101 continues to RUN.</td>
</tr>
<tr>
<td>5</td>
<td>Enable START pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STARTS and does not STOP during low station discharge pressure testing.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (YLA 150) at PNL 100.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>8</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that does not exceed Booster Pump P 101 capacity and that does not cause a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>9</td>
<td>Enable local Low Station Discharge Pressure alarm reset pushbutton (HMS 150) at PNL 100.</td>
</tr>
<tr>
<td>10</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.</td>
</tr>
<tr>
<td>12</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that exceeds Booster Pump P 101 capacity and that causes a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>13</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (PAL 150) at PNL 100.</td>
</tr>
<tr>
<td>14</td>
<td>Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm Booster Pump P 101 does NOT STOP.</td>
</tr>
<tr>
<td>16</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that does not exceed Booster Pump P 101 capacity and that does not cause a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>17</td>
<td>Enable Low Station Discharge Pressure alarm reset pushbutton (YCR 150) at CCS.</td>
</tr>
<tr>
<td>18</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.</td>
</tr>
<tr>
<td>19</td>
<td>Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.</td>
</tr>
<tr>
<td>20</td>
<td>Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.</td>
</tr>
</tbody>
</table>
### High Station Discharge Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that can keep Booster Pump P 101 running.
2. Enable START pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STARTS.
3. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that decreases pressure below a High Station Discharge Pressure alarm (PAH 110).
4. Confirm that Booster Pump P 101 does NOT STOP.
5. Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PNL 100.
6. Confirm High Station Discharge Pressure indication (PAH110) at HSQ/RTU and CCS.
7. Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PHL 100.
8. Confirm High Station Discharge Pressure alarm indication (PAH110) is OFF at CCS.
9. Enable local High Station Discharge Pressure alarm reset pushbutton (HMS 110) at PNL 100.
10. Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.
11. Confirm High Station Discharge Pressure alarm indication (PAH110) is OFF at CCS.
12. Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PHL 100.
13. Confirm High Station Discharge Pressure indication (PAH 110) at HSQ/RTU and CCS.
14. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that decreases pressure below a High Station Discharge Pressure alarm (PAH 110).
15. Enable High Station Discharge Pressure alarm reset pushbutton (YCR 110) at CCS.
16. Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.
17. Confirm High Station Discharge Pressure alarm indication (PAH110) is OFF at CCS.
18. Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.

### High Station Suction Pressure

1. Simulate High Booster Station Suction Pressure by increasing pressure to above High Station Suction Pressure Alarm setpoint (PSH 115).
2. Confirm High Station Suction Pressure Alarm indication (PAH 115) at HSQ/RTU and CCS.
3. Enable START pushbutton for Booster Pump P101 at MCC 100.
5. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 ON.
6. Confirm High Station Suction Pressure Alarm indication (PAH 115) automatically dears at HSQ/RTU and CCS when station suction pressure decreases and alarm condition no longer exists.
7. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
### J AUTO (PRESSURE SWITCH CONTROL) OPERATION

1. Adjust throttling valve on temporary booster station discharge pipe to a flow rate that keeps Booster Pump P 101 running.
2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.
3. Confirm AUTO position status indication (YIA 101A) at HSQ/RTU and CCS.
5. Confirm local RUN indication (YL 101) at MCC 100.
6. Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.
7. Confirm local ETM (KI 101) increases at MCC 100.
8. Confirm local motor amperage indication (II 101) for each phase at MCC 100.
9. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.

### K High Pump Discharge Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flow rate that keeps Booster Pump P 101 running.
2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.
3. Confirm Booster Pump P 101 is ON.
   - Monitor pressure indicator PI 101 and record time when pressure increases to cause a high pump discharge pressure switch (PSH 101) setpoint pressure. Note: For testing purposes adjust PSH 101 setpoint so that pump does not reach shutoff head.
5. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
7. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100.
8. Confirm local HIGH pump discharge pressure alarm indication (YLA 101A) at HSQ/RTU.
9. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS.
10. OPEN Booster Pump P 101 isolation valve (0038864).
11. Enable local alarm reset pushbutton (HMS 101C) for Booster Pump A101 at MCC 100.
12. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100 is OFF.
13. Confirm local HIGH pump discharge pressure alarm indication (YLA 101A) at HSQ/RTU is OFF.
14. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS is OFF.
15. Confirm Booster Pump P 101 starts.
16. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
L Low Station Suction Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.

2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.

3. Confirm Booster Pump P 101 is ON.

4. Simulate Low Booster Station Suction Pressure by decreasing pressure to below Low Station Suction Pressure Alarm setpoint (PSL 115). Monitor pressure indicator PI 135 to decrease pressure to reach the low station suction pressure switch (PSL 115) setpoint.

5. Confirm Booster Pump P 101 is OFF.

6. Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.

7. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.

8. Simulate Normal Booster Station Suction Pressure condition.

9. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.

10. Enable local low Station Suction Pressure alarm reset pushbutton (HMS 115) at PNL 100.

11. Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.

12. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.

13. Confirm Booster Pump P 101 is ON.

14. Simulate Low Booster Station Suction Pressure by decreasing pressure to below Low Station Suction Pressure Alarm setpoint (PSL 115). Monitor pressure indicator PI 135 to decrease pressure to reach the low station suction pressure switch (PSL 115) setpoint.

15. Confirm Booster Pump P 101 is OFF.

16. Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.

17. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.

18. Simulate Normal Booster Station Suction Pressure condition.

19. Enable Low Station Suction Pressure alarm reset (YCR 115) at CCS.

20. Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.

21. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.

22. Confirm Booster Pump P 101 is ON.

23. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
## Low Station Discharge Pressure

<table>
<thead>
<tr>
<th>M</th>
<th>Low Station Discharge Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.</td>
</tr>
<tr>
<td>2</td>
<td>Place Booster Pump P 101 HOAR selector switch in AUTO (pressure Switch Control) at MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>4</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that exceeds Booster Pump P 101 capacity and decreases pressure causing a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>5</td>
<td>Temporarily adjust setpoint of PAL 150 as needed to avoid pump from running too far to the right of its pump curve.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm Booster Pump P 101 continues to run. Confirm local Low Station Discharge Pressure alarm indication (YLA 150) at PNL 100.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>8</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that does not exceed Booster Pump P 101 capacity and increases pressure not causing a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>9</td>
<td>Enable local Low Station Discharge Pressure alarm reset pushbutton (HMS 150) at PNL 100.</td>
</tr>
<tr>
<td>10</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.</td>
</tr>
<tr>
<td>12</td>
<td>Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.</td>
</tr>
<tr>
<td>13</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that exceeds Booster Pump P 101 capacity and decreases pressure causing a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>14</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (PAL 150) at PNL 100.</td>
</tr>
<tr>
<td>16</td>
<td>Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>17</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that does not exceed Booster Pump P 101 capacity and increases pressure not causing a Low Station Discharge Pressure alarm (PAL 150).</td>
</tr>
<tr>
<td>18</td>
<td>Enable Low Station Discharge Pressure alarm reset pushbutton (YCR 150) at CCS.</td>
</tr>
<tr>
<td>19</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>20</td>
<td>Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.</td>
</tr>
<tr>
<td>21</td>
<td>Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.</td>
</tr>
<tr>
<td>22</td>
<td>Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.</td>
</tr>
<tr>
<td>N</td>
<td>High Station Discharge Pressure</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.</td>
</tr>
<tr>
<td>2</td>
<td>Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>4</td>
<td>CLOSE throttling valve on temporary booster station discharge pipe to increase pressure causing a High Station Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>5</td>
<td>Confirm Booster Pump P 101 is OFF, Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PNL 100.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm High Station Discharge Pressure indication (PAH110) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>7</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that decreases pressure below a High Station Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>8</td>
<td>Enable local High Station Discharge Pressure alarm reset pushbutton (HMS 110) at PNL 100.</td>
</tr>
<tr>
<td>9</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>10</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm High Station Discharge Pressure alarm indication (PAH 110) is OFF at CCS.</td>
</tr>
<tr>
<td>12</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that increases pressure above a High Station Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>13</td>
<td>Confirm Booster Pump P 101 is OFF.</td>
</tr>
<tr>
<td>14</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PNL 100.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm High Station Discharge Pressure alarm indication (PAH 110) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>16</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that decreases pressure below a High Station Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>17</td>
<td>Enable High Station Discharge Pressure alarm reset pushbutton (YCR 110) at CCS.</td>
</tr>
<tr>
<td>18</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.</td>
</tr>
<tr>
<td>19</td>
<td>Confirm High Station Discharge Pressure alarm indication (PAH 110) is OFF at CCS.</td>
</tr>
<tr>
<td>20</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>21</td>
<td>Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.</td>
</tr>
</tbody>
</table>
### High Station Suction Pressure

1. Simulate High Booster Station Suction Pressure by increasing pressure to above High Station Suction Pressure Alarm setpoint (PSH 115).

2. Confirm High Station Suction Pressure Alarm indication (PAH 115) at HSQ/RTU and CCS.

3. Place Booster Pump P 101 HOAR selector switch in AUTO (pressure Switch Control) at MCC 100.

4. Confirm Booster Pump P 101 is ON.

5. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.

6. Confirm High Station Suction Pressure Alarm indication (PAH 115) automatically clears at HSQ/RTU and CCS when discharge pressure decreases and alarm condition no longer exists.

7. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.

### REMOTE (HSQ/RTU CCS CONTROL) OPERATION

1. Confirm HSQ/RTU OK output.

2. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.

3. Place Booster Pump P 101 HOAR selector switch in REMOTE (HSQ/RTU CCS Control) at MCC 100.

4. Confirm REMOTE position status indication (YIA 101C) at HSQ/RTU and CCS.

5. Confirm Booster Pump P 101 starts.

6. Confirm HSQ START command is enabled. Confirm local RUN indication (YL 101) at MCC 100.

7. Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.

8. Confirm local ETM (KI 101) increases at MCC 100.

9. Confirm local motor amperage indication (II 101) for each phase at MCC 100.

10. Partially CLOSE throttling valve on temporary booster station discharge pipe to a flowrate that causes Booster Pump P 101 to STOP.

11. Confirm HSQ STOP command is enabled.
Section 5  |  Verification Testing
Section 5: Verification Testing

Details: The Verification Testing goal is 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.

A Test Setup form shall be completed for each test group which tells how the system will be operated during testing. Defining test configurations, temporary connections, and bypass connections. Test Setup form also informs every one how much waste there will be and the approximate test duration plus shows who will be involved in the testing to ensure all parties are present. Lastly, the form can be utilized to detail why a scenario or equipment can not be tested due to process demands or unattainable configurations.

Verification Test plan should be developed for each test group to show every function, on each piece of equipment, operates properly and each piece of equipment operates as designed. The plan will clearly show every aspect of the system works in various conditions as described in the Control descriptions and detailed in the Process and Instrumentation drawings. The Verification Testing can only start after all Equipment Setup and Checkout items are completed by the Contractor. To verify all pre-activities are complete for each test group, the following Pre Verification Test Check list will need to be complete. During the Verification Testing the Contractor, Subcontractors, Owner’s Representative, and Engineer will be involved. Since the instruments have been calibrated, the installation certified, and the I/O tested, it is expected that these plans will be similar but more compressed into systems and sub-systems than the Contractors Functional testing.

**During this testing the Contractor, Subcontractors, and Owner’s Representative will be involved at a minimum.

<table>
<thead>
<tr>
<th>Description</th>
<th>Q.C. Initial / Date</th>
<th>Owner Rep. Initial / Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>All instrumentation calibration complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All manufacture certificate of installation complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All items on the Equipment and Instrumentation Checkout Log complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O testing complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor Functional testing complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary O&amp;M manual complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approval of Construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required permitting submitted and complete</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Items to be included in the Verification section:

1. Individual Verification Test Setup
2. Individual Verification Test Plan with Sign-off
**Test Setup**

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Location:</th>
<th>MCC</th>
</tr>
</thead>
</table>

**Test System Group:** *A - Service Entrance Section*

**Detailed Test Configuration, temporary connections, and bypass:**

The testing of the Service entrance section and power distribution system doesn’t require any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components, (Hardware checkout).

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>N/A</th>
<th>Est. Flow / Usage (mgd):</th>
<th>N/A</th>
</tr>
</thead>
</table>

**System Limitation:** *All components can be tested.*

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

Prepared By: *Name and Company*

**See the Test System Layout for a list of items being tested**
### Verification Test Plan

**Project:** Sample Equipment/System Name: Service Entrance Section

**Contractor:**

**Reference Drawing:** E010 and E011

#### Test Group: A - Service Entrance Section

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

**A** Pre-Test Checks

1. All Contractor starting and placing equipment in operation and equipment and
2. Verification of calibration and pump capacities is to be complete prior to start of
3. Contractor shall ensure all valve open-close positions are correct prior to starting

**B** Electric Power Service Entrance Section SES 101 and Customer Power Metering Systems

1. OPEN all branch circuit breakers in Panel LP-02.
2. OPEN main breaker in Panel LP-02.
3. OPEN all branch circuit breakers in Standby Generator GEN 121 panel.
4. OPEN main circuit breaker at Standby Generator GEN 121.
5. OPEN submain circuit breakers in Motor Control Center MCC 100.
6. OPEN main circuit breaker in Motor Control Center MCC 100.
7. OPEN main circuit breaker in Service Entrance Section SES 100.
8. Energize APS transformer TX596411 (500 KVA, 277/480V).
9. CLOSE main circuit breaker in Service Entrance Section SES 100.
10. CLOSE main circuit breaker in Motor Control Center MCC 100.
11. CLOSE circuit breaker at MCC 100 for Panel LP-02.
12. CLOSE main breaker in Panel LP-02.
13. CLOSE Circuit 6 breaker in Panel LP-02.
14. Read and document the following data using PQM 100 locally: peak demand real
15. Read and document the following data at HSQ/RTU and CCS: peak demand real

**All associated tasks must be completed to verify the test objective was completed**
### C Electric Power Service Entrance Section SES 101

1. OPEN branch circuit breakers in Distribution Panel LP-01.
2. OPEN main circuit breaker in Service Entrance Section SES 101.
3. Energize APS transformer TX596412 (50 KVA, 120/240V).
4. CLOSE main circuit breaker in Service Entrance Section SES 101.
5. CLOSE all branch circuit breakers with loads.

### D Electric Power Distribution System

1. CLOSE submain circuit breakers in Motor Control Center MCC 100.
2. CLOSE main circuit breaker at Standby Generator GEN 121.
3. CLOSE branch circuit breakers in Distribution Panel LP-02.
4. Confirm remaining correct operation during testing described in each section below.
<table>
<thead>
<tr>
<th>Test System Group:</th>
<th>B - HSQ Remote Terminal Unit (RTU) Panel including CCS Communication System</th>
</tr>
</thead>
</table>

**Detailed Test Configuration, temporary connections, and bypass:**

The testing of the RTU and CCS system doesn’t require any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components, (Hardware checkout).

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Flow / Usage (mgd):</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**System Limitation:**

*All components can be tested.*

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
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</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

| Prepared By: | Name and Company |

**See the Test System Layout for a list of items being tested**
**Verification Test Plan**

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment/System Name:</td>
<td>RTU</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Reference Drawing:</td>
</tr>
<tr>
<td></td>
<td>E028</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Contractor</th>
<th>Owner Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Tasks Description</td>
<td>Verified</td>
<td>Date</td>
</tr>
<tr>
<td>A Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Electric Power Supply and Associated Alarms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Panel Lighting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| D Uninterruptable Power Supply (UPS) | | | | | **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 Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placing equipment in operation and equipment and system startup and testing.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-close positions are correct prior to starting each test below.</td>
<td></td>
</tr>
<tr>
<td>B Electric Power Supply and Associated Alarms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Confirm HSQ/RTU Power Fail Alarm (JA 114) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Confirm HSQ/RTU OK Permissive (YC 102) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>OPEN circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTU Panel</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Confirm HSQ/RTU Panel Power Fail Alarm (JA 114) is enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>C Panel Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Confirm proper function of internal HSQ/RTU panel lighting and receptacle.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uninterruptable Power Supply (UPS)</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CLOSE circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTUPanel.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>indicated.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Enable test button on UPS. Confirm that no alarm beeps or alarm indicator stays ON.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>OPEN circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTUPanel.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Confirm battery mode indicator is ON and alarm beeps twice every two seconds.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Confirm all devices and input/output cards connected to UPS remain powered.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CLOSE circuit breaker in Lighting Panel LP 02 that supplies main electric power to HSQ/RTU Panel.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Indicated.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Digital and Analog Inputs and Outputs.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Confirm proper operation of HSQ/RTU Panel when performing tests for other systems.</td>
<td></td>
</tr>
<tr>
<td><strong>Test Setup</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Project:</strong></td>
<td>Sample</td>
<td></td>
</tr>
<tr>
<td><strong>Location:</strong></td>
<td>MCC</td>
<td></td>
</tr>
<tr>
<td><strong>Test System Group:</strong></td>
<td>C - Disinfection System PLC Panel PNL 201</td>
<td></td>
</tr>
</tbody>
</table>

**Detailed Test Configuration, temporary connections, and bypass:**

The testing of the PNL 201 system doesn’t required any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components, (Hardware checkout).

**Est. Duration (hr):** N/A  
**Est. Flow / Usage (mgd):** N/A

**System Limitation:** All components can be tested.

---

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
<td></td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
<td></td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
<td></td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
<td></td>
</tr>
</tbody>
</table>

Prepared By: **Name and Company**

**See the Test System Layout for a list of items being tested**
## Verification Test Plan

**Project:** Sample  
**Equipment/System Name:** Disinfection System  
**Contractor:**  
**Reference Drawing:** E011 and E012

### Test Group: C - Disinfection System PLC Panel PNL 201

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Contractor</th>
<th>Owner Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Description Verified</td>
<td>Verified Date</td>
<td>Verified Date</td>
</tr>
<tr>
<td>A  Pre-Test Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B  Electric Power Supply and Associated Alarms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C  Panel Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D  Uninterruptable Power Supply (UPS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E  Air Conditioner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F  Operator Interface (OIT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G  Programmable Logic Controller (PLC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 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><strong>A</strong></td>
<td>Pre-Test Checks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placing equipment in operation and equipment and system startup and</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verification of calibration and pump capacities is to be complete prior to start of final operational</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.</td>
<td></td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>Electric Power Supply and Associated Alarms</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CLOSE circuit breaker (LPO1-14,16) in Lighting Panel LP 01 that supplies electric power to panel air conditioner.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CLOSE circuit breaker (LPO1-9) in Lighting Panel LP 01 that supplies electric power to LP 01 Power Fail Alarm (JSL 100).</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CLOSE circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to disinfection System Panel.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Confirm LP 01 Power Fail Alarm (JA 100) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Confirm Disinfection System Panel PNL 201 Power Fail Alarm (JA 101) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>OPEN circuit breaker (LP01-9) in Lighting Panel LP 01.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Confirm LP 01 Power Fail Alarm (JA 100) is enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>OPEN circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to Disinfection System Panel.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Confirm Disinfection System Panel PNL 201 Power Fail Alarm (JA 101) is not enabled at HSQ/RTU and CCS.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Panel Lighting</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Confirm proper function of internal PNL 201 panel lighting and receptacle.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D</th>
<th>Uninterruptable Power Supply (UPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CLOSE circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to disinfection System Panel.</td>
</tr>
<tr>
<td>2</td>
<td>Confirm normal mode indicator is ON and not flashing and percentage of UPS load capacity is indicated.</td>
</tr>
<tr>
<td>3</td>
<td>Enable test button on UPS. Confirm that no alarm beeps or alarm indicator stays ON.</td>
</tr>
<tr>
<td>4</td>
<td>OPEN circuit breaker (LP02-8) in Lighting Panel LP 02 that supplies main electric power to Disinfection System Panel.</td>
</tr>
<tr>
<td>5</td>
<td>Confirm battery mode indicator is ON and alarm beeps twice every two seconds.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm all devices and input/output cards connected to UPS remain powered.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E</th>
<th>Air Conditioner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OPEN circuit breaker (LPOJ-14,16) in Lighting Panel LP 01 that supplies electric power to panel air conditioner.</td>
</tr>
<tr>
<td>2</td>
<td>Confirm panel air conditioner will not run.</td>
</tr>
<tr>
<td>3</td>
<td>CLOSE circuit breaker (LPOJ-14,J6) in Lighting Panel LP 01 that supplies electric power to panel air conditioner.</td>
</tr>
<tr>
<td>4</td>
<td>Confirm panel air conditioner runs automatically and turns off.</td>
</tr>
<tr>
<td>5</td>
<td>Measure temperature inside panel within 5 seconds of turn air conditioner off.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F</th>
<th>Operator Interface (OIT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confirm each OIT process graphic screen.</td>
</tr>
<tr>
<td>2</td>
<td>Confirm specific alarms and monitoring data when performing tests for other systems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>G</th>
<th>Programmable Logic Controller (PLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confirm proper operation of PLC when performing tests for other systems.</td>
</tr>
</tbody>
</table>
### Test Setup

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>MCC</td>
</tr>
</tbody>
</table>

**Test System Group:** *D - Lighting System*

**Detailed Test Configuration, temporary connections, and bypass:**

The testing of the lighting system doesn't require any usage of process water or chemicals. The steps defined in the Testing Plan will verify the system components, (Hardware checkout).

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Flow / Usage (mgd):</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**System Limitation:** *All components can be tested.*

**Required Personnel to Complete Testing:**

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

**Prepared By:** Name and Company

**See the Test System Layout for a list of items being tested**
## Verification Test Plan

<table>
<thead>
<tr>
<th>Project: Sample</th>
<th>Equipment/System Name: Lighting System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Reference Drawing:</td>
</tr>
</tbody>
</table>

### Test Group: D - Lighting System

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Contractor</th>
<th>Owner Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Tasks</td>
<td>Description</td>
<td>Verified</td>
</tr>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Site Lighting</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Electrical Equipment Area Lighting</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Disinfection Building Lighting</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Site Electrical Receptacles</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Electrical Equipment Area Electrical Receptacles</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Disinfection Building Electrical Receptacles</td>
<td></td>
</tr>
</tbody>
</table>

Note: 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 Checks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All Contractor starting and placing equipment in operation and equipment and system startup are to</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verification of calibration and pump capacities is to be complete prior to start of final operational</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Site Lighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker (LP 01-5) in Lighting Panel LP 01 that supplies electric power to perimeter lights.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable switch adjacent to slide gate and verify all lights are ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch and verify all lights are OFF.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Electrical Equipment Area Lighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lights.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable switch on shade canopy column and verify all lights are ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch and verify all lights are OFF.</td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td><strong>Disinfection Building Lighting</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable switch adjacent to door and verify all lights inside and outside are ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch and verify all lights are OFF.</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td><strong>Site Electrical Receptacles</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker feeding receptacles and verify all receptacles are energized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable site lighting switch and verify all receptacles are energized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OPEN circuit breaker feeding receptacles and verify all receptacles are not energized.</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td><strong>Electrical Equipment Area Electrical Receptacles</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker feeding receptacles and verify all receptacles are energized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch on shade canopy column and verify all receptacles are energized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OPEN circuit breaker feeding receptacles and verify all receptacles are not energized.</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td><strong>Disinfection Building Electrical Receptacles</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSE circuit breaker feeding receptacles and verify all receptacles are energized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable switch adjacent to door and verify all receptacles are energized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OPEN circuit breaker feeding receptacles and verify all receptacles are not energized.</td>
<td></td>
</tr>
</tbody>
</table>
### Test Setup

<table>
<thead>
<tr>
<th><strong>Project:</strong></th>
<th><strong>Location:</strong></th>
<th><strong>Test System Group:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>MCC and Pump P101</td>
<td>E - Suction Hydropneumatic Tank T-140 and Air Compressor 1 C-140</td>
</tr>
</tbody>
</table>

**Detailed Test Configuration, temporary connections, and bypass:** The hydropneumatic tank will initially be filled with water to about half of the tank, then pressure will be manually added from the compressor to get to pressure about 25psi. From there the pressure and level indicators can be verified. Then the probe well will be isolated and the water level changed to simulate conditions and verify control.

**Est. Duration (hr):** 4 hours  
**Est. Flow / Usage (gal):** 2000 gal

**System Limitation:** All components can be tested.

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>Role</th>
<th>Name and Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Contractor:</td>
<td></td>
</tr>
<tr>
<td>Electrical Contractor:</td>
<td></td>
</tr>
<tr>
<td>Programmer:</td>
<td></td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td></td>
</tr>
<tr>
<td>Engineer:</td>
<td></td>
</tr>
<tr>
<td>Construction Manager:</td>
<td></td>
</tr>
<tr>
<td>Inspector:</td>
<td></td>
</tr>
<tr>
<td>Safety Personnel:</td>
<td></td>
</tr>
<tr>
<td>Mechanical Contractor:</td>
<td></td>
</tr>
<tr>
<td>Quality Control Manager:</td>
<td></td>
</tr>
</tbody>
</table>

**See attached Test System Layout for a list of items being tested**
## Verification Test Plan

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Equipment/System Name:</th>
<th>Hydropneumatic Tank T-140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td></td>
<td>Reference Drawing:</td>
<td>I-005</td>
</tr>
</tbody>
</table>

### Test Group: E - Suction Hydropneumatic Tank T-140 and Air Compressor 1 C-140

<table>
<thead>
<tr>
<th>Completed test objective</th>
<th>Sign off</th>
<th>Contractor</th>
<th>Owner Representative</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Tasks</td>
<td>Description</td>
<td>Verified</td>
<td>Date</td>
<td>Verified</td>
</tr>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>HAND OPERATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>High Air Pressure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Motor Overload</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Low Lube Oil Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Suction Hydropneumatic Tank Water Level High High (LSHH #140)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Low Booster Station Suction Pressure (PSL #115)- Local Reset</td>
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<tr>
<td>I</td>
<td>Low Booster Station Suction Pressure (PSL #115)- CCS Reset</td>
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<tr>
<td>J</td>
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<tr>
<td>M</td>
<td>Low Lube Oil Level</td>
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<tr>
<td>N</td>
<td>Suction Hydropneumatic Tank Water Level High High (LSHH #140)</td>
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<tr>
<td>O</td>
<td>Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)</td>
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<td>P</td>
<td>Low Booster Station Suction Pressure (PSL #115)- Local Reset</td>
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<tr>
<td>Q</td>
<td>Low Booster Station Suction Pressure (PSL #115)- CCS Reset</td>
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</tbody>
</table>

**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 Checks</td>
<td></td>
</tr>
</tbody>
</table>

1. All Contractor starting and placing equipment in operation and equipment and system startup are to
2. Verification of calibration and pump capacities is to be complete prior to start of final operational
3. Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.
### B  HAND OPERATION

1. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is OFF at motor control center, MCC 100.
2. Enable all disconnects and circuit breakers that feed power to air compressor.
3. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
4. Confirm air compressor does not start.
5. Place Hand-Off-Auto (HOA) selector switch for air compressor in HAND at motor control center, MCC 100.
6. Enable START push button for air compressor at MCC 100.
7. Confirm air compressor starts.
8. Confirm solenoid valve SV -140 on air line to Suction Hydropneumatic Tank T 140 automatically opens.
9. Confirm local RUN indication (YIR 140) at MCC 100.
10. Confirm RUN indication (YIR 140) at HSQ/RTU and CCS.
11. Confirm local ETM (KI 140) increases at MCC 100.

### C  High Air Pressure

1. Close shutoff valve in air compressor discharge line at hydropneumatic tank.
2. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
3. Monitor pressure until pressure increases and reaches the high air pressure switch (PSH 140) setpoint pressure.
4. Confirm air compressor STOPS after time delay TDR1.
5. Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.
6. Confirm local HIGH air pressure alarm indication (fLA 140C) at MCC 100.
7. Confirm HIGH air pressure alarm indication (PAN 140) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
9. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
10. Enable START push button for air compressor at MCC 100.
11. Confirm air compressor does NOT start.
12. Open shutoff valve and clear high pressure air condition.
13. Enable local High Pressure alarm reset push button (HMS 140A) at MCC100.
14. Confirm local High Pressure alarm indication (YA 140C) is OFF at MCC100.
15. Confirm HIGH air pressure alarm indication (PAH 140) at HSQ/RTU automatically resets and is OFF.
16. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
17. Enable START push button for air compressor at MCC 100.
18. Confirm air compressor starts.
### D Motor Overload

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Trip motor overload at MCC 100.
3. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
4. Enable START push button for air compressor at MCC 100.
5. Confirm air compressor does NOT start.
6. Confirm local Air Compressor 1 Failure alarm indication (YA 140B) at MCC 100.
7. Confirm Air Compressor 1 Failure alarm indication (YA 140B) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
10. Enable local Air Compressor 1 Failure alarm reset push button (BMS 140A) at MCC 100.
11. Confirm local Air Compressor 1 Failure alarm indication (YA 140C) is OFF at MCC 100.
12. Confirm Air Compressor 1 Failure alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.
13. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
14. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
15. Enable START push button for Air Compressor 1 at MCC 100 and confirm air compressor starts.

### E Low Lube Oil Level

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Simulate a low lube oil level alarm.
3. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
4. Enable START push button for air compressor at MCC 100.
5. Confirm air compressor does NOT start.
6. Confirm local Air Compressor 1 Low Lube Oil Alarm indication (YA 140A) at MCC 100.
7. Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140A) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
10. Enable local Air Compressor 1 Low Lube Oil alarm, reset push button (HMS 140A) at MCC100.
11. Confirm local Air Compressor 1 Low Lube Oil alarm indication (YA 140A) is OFF at MCC 100.
12. Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.
13. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
14. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
15. Enable START push button for Air Compressor 1 at MCC 100 and confirm air compressor starts.
### F Suction Hydropneumatic Tank Water Level High High (LSHH #140)

1. LSHH140. This will overcome the concern of allowing air out of hydro pneumatic tank through the pressure.
2. Confirm Suction Hydropneumatic Tank Water Level High High alarm indication (LAHH 140) at HSQ/RTU and CCS.
3. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
4. Enable START push button for air compressor at MCC 100.
5. Confirm air compressor starts.
6. Enable STOP push button for air compressor at MCC 100 to stop compressor.
7. Lower water level in suction hydropneumatic tank to below LSHH 140.
8. CCS automatically reset and are OFF.

### G Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)

1. Isolate the level probe bottle and lower water level in suction hydropneumatic tank probe bottle to reach LSLL 140.
2. Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication (ULL 140) at HSQ/RTU and CCS.
3. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
4. Enable START push button for air compressor at MCC 100.
5. Confirm air compressor will NOT start.
6. Raise water level in suction hydropneumatic tank probe bottle to above LSH140.
7. CCS automatically reset and are OFF.
8. Enable START push button for air compressor at MCC 100.
9. Confirm air compressor starts.

### I Low Booster Station Suction Pressure (PSL #115)- CCS Reset

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.
3. Enable START push button for air compressor at MCC 100.
4. Confirm air compressor starts.
5. Simulate Low Booster Station Suction Pressure (PSL 115) using block and bleed valve and/or test ports at Panel PNL-115.
6. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
7. Confirm air compressor does NOT stop.
8. Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.
9. Enable local alarm reset push button at PNL 100 at MCC 100.
10. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNL 100 at MCC 100.
11. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.

<table>
<thead>
<tr>
<th>H</th>
<th>Low Booster Station Suction Pressure (PSL #115) - Local Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td>2</td>
<td>Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in HAND at motor control center, MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Enable START push button for air compressor at MCC 100.</td>
</tr>
<tr>
<td>4</td>
<td>Confirm air compressor starts.</td>
</tr>
<tr>
<td>5</td>
<td>Simulate Low Booster Station Suction Pressure (PSL 115).</td>
</tr>
<tr>
<td>6</td>
<td>Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm air compressor does NOT stop.</td>
</tr>
<tr>
<td>8</td>
<td>Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.</td>
</tr>
<tr>
<td>9</td>
<td>Enable CCS alarm reset push button.</td>
</tr>
<tr>
<td>10</td>
<td>Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNLL 100 at MCC 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.</td>
</tr>
</tbody>
</table>

### AUTOMATIC OPERATION

- Confirm Hand-Off-Auto (HOA) selector switch for air compressor is OFF at motor control center, MCC 100.
- Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
- Place Hand-Off-Auto (HOA) selector switch for air compressor in AUTO at motor control center, MCC 100.
- Confirm air compressor starts.
- Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.
- Confirm local RUN indication (YL 140) at MCC 100.
- Confirm RUN indication (YIR 140) at HSQ/RTU and CCS.
- Confirm local ETM (KI 140) increases at MCC 100.

### K High Air Pressure

1. Close shutoff valve in air compressor discharge line at hydropneumatic tank.
2. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
3. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
4. Confirm air compressor starts and then STOPS after time delay TDR1.
5. Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.
6. Confirm local HIGH air pressure alarm indication (YA 140C) at MCC 100.
7. Confirm HIGH air pressure alarm indication (PAR 140) at HSQ/RTU.
8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
9. Open shutoff valve and clear high pressure air condition.
10. Enable local High Pressure alarm reset push button (HMS 140A) at MCC 100.
11. Confirm local High Pressure alarm indication (YA 140C) is OFF at MCC 100.
12. Confirm HIGH air pressure alarm indication (PAR 140) at HSQ/RTU automatically resets and is OFF.
13. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.
14. If necessary, raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
15. Confirm air compressor starts.
16. Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.

#### Section 5 Verification Testing

<table>
<thead>
<tr>
<th><strong>L</strong></th>
<th><strong>Motor Overload</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td>2.</td>
<td>Trip motor overload at MCC 100.</td>
</tr>
<tr>
<td>3.</td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td>4.</td>
<td>Confirm air compressor does NOT start.</td>
</tr>
<tr>
<td>5.</td>
<td>Confirm local Air Compressor 1 Failure alarm indication (YA 140B) at MCC 100.</td>
</tr>
<tr>
<td>6.</td>
<td>Confirm Air Compressor 1 Failure alarm indication (YA 140B) at HSQ/RTU.</td>
</tr>
<tr>
<td>7.</td>
<td>Confirm Air Compressor Failure alarm indication (YA 140B) at CCS.</td>
</tr>
<tr>
<td>8.</td>
<td>Reset motor overload.</td>
</tr>
<tr>
<td>9.</td>
<td>Enable local Air Compressor 1 Failure alarm reset push button (HMS 140A) at MCC 100.</td>
</tr>
<tr>
<td></td>
<td>Confirm local Air Compressor 1 Failure alarm indication (YA 140C) is OFF at MCC 100.</td>
</tr>
<tr>
<td></td>
<td>Confirm Air Compressor 1 Failure alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.</td>
</tr>
<tr>
<td></td>
<td>Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.</td>
</tr>
<tr>
<td></td>
<td>Confirm air compressor starts.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>M</strong></th>
<th><strong>Low Lube Oil Level</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.</td>
</tr>
<tr>
<td>2.</td>
<td>Simulate a low lube oil level alarm.</td>
</tr>
<tr>
<td>3.</td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td>4.</td>
<td>Confirm air compressor does NOT start.</td>
</tr>
<tr>
<td>5.</td>
<td>Confirm local Air Compressor 1 Low Lube Oil Alarm indication (YA 140A) at MCC 100.</td>
</tr>
<tr>
<td>6.</td>
<td>Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140A) at HSQ/RTU.</td>
</tr>
<tr>
<td>7.</td>
<td>Confirm Air Compressor 1 General Trouble alarm indication at CCS.</td>
</tr>
<tr>
<td>8.</td>
<td>Clear simulated low lube oil level condition.</td>
</tr>
<tr>
<td>9.</td>
<td>Enable local Air Compressor 1 Low Lube Oil alarm reset push button - (HMS 140A) at MCC 100.</td>
</tr>
<tr>
<td>10.</td>
<td>Confirm local Air Compressor 1 Low Lube Oil alarm indication (YLA 140A) is OFF at MCC 100.</td>
</tr>
<tr>
<td>11.</td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td>12.</td>
<td>Confirm air compressor starts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>N</strong></th>
<th><strong>Suction Hydropneumatic Tank Water Level High High (LSHH #140)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSHH 140. This could allow air out of hydropneumatic tank.</td>
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<tr>
<td></td>
<td>Confirm Suction Hydropneumatic Tank Water Level High High alarm indication (LAHH 140) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td></td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td></td>
<td>Lower water level in suction hydropneumatic tank to below LSHH 140.</td>
</tr>
<tr>
<td></td>
<td>CCS automatically reset and are OFF.</td>
</tr>
</tbody>
</table>
### O  Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)

- Lower water level in suction hydropneumatic tank to reach LSLL 140.
- Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication (LALL 140) at HSQ/RTU and CCS.
- Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
- Confirm air compressor will NOT start.
- Raise water level in suction hydropneumatic tank to above LSH 140.
- Confirm air compressor starts.

### P  Low Booster Station Suction Pressure (PSL #115) - Local Reset

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
3. Confirm air compressor starts.
4. Simulate Low Booster Station Suction Pressure (PSL 115).
5. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
6. Confirm air compressor stops.
7. Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.
8. Enable local alarm reset push button at PNL 100 at MCC 100.
9. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNL J00 at MCC J00.
10. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.
11. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
12. Confirm air compressor starts.

### Q  Low Booster Station Suction Pressure (PSL #115) - CCS Reset

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
3. Confirm air compressor starts.
4. Simulate Low Booster Station Suction Pressure (PSL 115).
5. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
6. Confirm air compressor stops.
## Test Setup

<table>
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<tr>
<th>Project:</th>
<th>Sample</th>
<th>Location:</th>
<th>MCC and Pump P101</th>
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<tbody>
<tr>
<td><strong>Test System Group:</strong></td>
<td>F - Booster Pump P101</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Detailed Test Configuration, temporary connections, and bypass:

1. 4" HDPE temporary piping will be run from the pump discharge header to the drainage area to the south of the site. The temporary piping will be connected at the 90 degree fitting just prior to the 4in PD going underground. The temporary piping will be routed south along the east fence and a small hole will be dug to go under the chain link fence and into the drainage area.

### Est. Duration (hr): 3 hours

### Est. Flow / Usage (mgd): 0.25

### System Limitation:

*A maximum of 1ft of discharge will be allow to develop during testing in the drainage area.*

## Required Personnel to Complete Testing:

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
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<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By:** Name and Company

**See attached Test System Layout for a list of items being tested**
## Contractor's Functional Test Plan

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Equipment/System Name:</th>
<th>Pump #101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td></td>
<td>Reference Drawing:</td>
<td>I008</td>
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</table>

Test Group: F - Booster Pump P 101

<table>
<thead>
<tr>
<th>Completed test objective</th>
<th>Sign off</th>
<th>Associated Tasks</th>
<th>Description</th>
<th>Contractor</th>
<th>Owner Representative</th>
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</thead>
<tbody>
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<td>Pre-Test Checks</td>
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<td>B</td>
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<td></td>
<td>HAND OPERATION</td>
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<tr>
<td>C</td>
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<td>Motor Overload (Motor Starter)</td>
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<td>D</td>
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<td>Motor Overload (Motor Saver)</td>
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<td>E</td>
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<td>High Pump Discharge Pressure</td>
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<td>F</td>
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<td>High Station Discharge Pressure</td>
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<td>I</td>
<td></td>
<td></td>
<td>High Station Suction Pressure</td>
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<tr>
<td>J</td>
<td></td>
<td></td>
<td>AUTO (PRESSURE SWITCH CONTROL) OPERATION</td>
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<tr>
<td>K</td>
<td></td>
<td></td>
<td>High Pump Discharge Pressure</td>
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<td>L</td>
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<td>O</td>
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<td>High Station Suction Pressure</td>
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<tr>
<td>P</td>
<td></td>
<td></td>
<td>REMOTE (HSQ/RTU CCS CONTROL) OPERATION</td>
<td></td>
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</tr>
</tbody>
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1. All Contractor starting and placing equipment in operation and equipment and system startup are to
2. Verification of calibration and pump capacities is to be complete prior to start of final operational
3. Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.
## HAND OPERATION

1. Enable all disconnects and circuit breakers that feed power to Booster Pump P 101.
2. Confirm Booster Pump P 101 does not start.
3. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.
4. Place Booster Pump P 101 HOAR selector switch in HAND (Local Manual) at MCC 100.
5. Confirm HAND position status indication (YLA 101B) at HSQ/RTU and CCS.
6. Enable START push button for Booster Pump P101 at MCC 100.
7. Confirm Booster Pump P 101 starts.
8. Confirm local RUN indication (YL 101) at MCC 100.
9. Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.
10. Confirm local ETM (KI 101) increases at MCC 100.
11. Confirm local motor amperage indication (II 101) for each phase at MCC 100.
12. Enable STOP push button for Booster Pump P 101 at MCC 100 and confirm pump STOPS.

## Motor Overload (Motor Starter)

1. Simulate motor overload at MCC 100.
2. Place Booster Pump P 101 HOAR selector switch in HAND (Local Manual) at MCC 100.
3. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump does not START.
4. Confirm local motor overload alarm indication (YA 101B) at MCC 100.
5. Confirm Booster Pump P-101 motor overload alarm indication (YA 101B) at HSQ/RTU.
6. Confirm Booster Pump P-101 motor overload alarm indication at CCS.
7. Enable motor overload reset for Booster Pump P 101 at MCC 100.
8. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump starts.
9. Confirm Booster Pump P-101 motor overload alarm indications at HSQ/RTU and CCS are OFF.
10. Enable STOP push button for Booster Pump P 101 at MCC 100.
### D Motor Overload (Motor Saver)

1. Simulate high motor current at MCC 100.
2. Place Booster Pump P 101 HOAR selector switch in HAND (Local Manual) at MCC 100.
3. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump does not START.
4. Confirm no local motor overload alarm indication (YLA 101B) at MCC 100.
5. Confirm no Booster Pump P-101 motor overload alarm indication (YLA 101B) at HSQ/RTU.
6. Confirm no Booster Pump P-101 General Trouble alarm indication at CCS.
7. Clear high motor current condition at MCC 100.
8. Enable START pushbutton for Booster Pump P 101 at MCC 100 after time delay 0/motor saver and confirm pump STARTS.
9. Enable STOP pushbutton for Booster Pump P 101 at MCC 100.

### E High Pump Discharge Pressure

1. Partially CLOSE Booster Pump P 101 isolation valve (0038864).
2. Enable START pushbutton for Booster Pump P 101 at MCC 100.
3. Enable START pushbutton for Booster Pump P 101 at MCC 100 after time delay 0/motor saver and confirm pump STARTS.
5. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100.
6. Confirm Booster Pump P 101 HIGH pump discharge pressure alarm (YA 101A) at HSQ/RTU.
7. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS.
8. OPEN Booster Pump P 101 isolation valve (0038864).
9. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump does not start.
10. Enable local alarm reset pushbutton (HMS 101C) for Booster Pump P 101 at MCC 100.
11. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump starts.
12. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100 is OFF.
13. Confirm Booster Pump P 101 High Pump Discharge Pressure alarm (YA 101A) at HSQ/RTU is OFF.
14. Confirm Booster Pump P 101 General Trouble alarm at CCS is OFF.
15. Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.
### F Low Station Suction Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.

2. Station suction pressure switch (PSL 115) setpoint.

3. And does NOT STOP.

4. Confirm local Low Station Suction pressure alarm indication (PAL 115) at PNL 100.

5. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.

6. Station suction pressure switch (PSL 115) setpoint.

7. Enable local Low Station Suction Pressure alarm reset pushbutton (HMS 115) at PNL 100.

8. Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.

9. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.

10. Station suction pressure switch (PSL 115) setpoint.

11. Confirm Booster Pump P 101 does NOT STOP.

12. Station suction pressure switch (PSL 115) setpoint.

13. Enable Low Station Suction Pressure alarm reset (YCR 115) at CCS.

14. Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.

15. Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.

16. Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.

### G Low Station Discharge Pressure

1. Place Booster Pump P 101 HOAR selector switch in HAND (Local Manual) at MCC 100.

2. Enable START push button for Booster Pump P 101 at MCC 100 and confirm pump does START.

3. 101 capacity and decreases pressure causing a Low Station Discharge Pressure alarm (PAL 150).

4. Adjust PSL 150 setpoint if necessary. Confirm that Booster Pump P 101 continues to RUN.

5. STOP during low station discharge pressure testing.

6. Confirm local Low Station Discharge Pressure alarm indication (YLA 150) at PNL 100.

7. Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.

8. Pump P 101 capacity and that does not cause a Low Station Discharge Pressure alarm (PAL 150).

9. Enable local Low Station Discharge Pressure alarm reset pushbutton (HMS 150) at PNL 100.

10. Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.

11. Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.

12. 101 capacity and that causes a

13. Low Station Discharge Pressure alarm (PAL 150).

14. Confirm local Low Station Discharge Pressure alarm indication (PAL 150) at PNL 100.

15. Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.

16. Confirm Booster Pump P 101 does NOT STOP.

17. Pump P 101 capacity and that does not cause a Low Station Discharge Pressure alarm (PAL 150).

18. Enable Low Station Discharge Pressure alarm reset pushbutton (YCR 150) at CCS.

19. Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.

20. Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.

21. Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.
**H High Station Discharge Pressure**

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that can keep Booster Pump P 101 running.
2. Enable START pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STARTS.
3. Discharge Pressure alarm (PAH 110).
4. Confirm that Booster Pump P 101 does NOT STOP.
5. Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PNL 100.
6. Confirm High Station Discharge Pressure indication (PAH110) at HSQ/RTU and CCS.
7. High Station Discharge Pressure alarm (PAH110).
8. Enable local High Station Discharge Pressure alarm reset pushbutton (HMS 110) at PNL 100.
9. Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.
10. Confirm High Station Discharge Pressure alarm indication (PAH110) is OFF at CCS.
11. Discharge Pressure alarm (PAH 110).
12. Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PHL 100.
13. Confirm High Station Discharge Pressure indication (PAH 110) at HSQ/RTU and CCS.
14. High Station Discharge Pressure alarm (PAH 110).
15. Enable High Station Discharge Pressure alarm reset pushbutton (YCR 110) at CCS.
16. Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.
17. Confirm High Station Discharge Pressure alarm indication (PAH110) is OFF at CCS.
18. Enable STOP pushbutton for Booster Pump P 101 at MCC 100 and confirm pump STOPS.

**I High Station Suction Pressure**

1. Alarm setpoint (PSH 115).
2. Confirm High Station Suction Pressure Alarm indication (PAH 115) at HSQ/RTU and CCS.
3. Enable START pushbutton for Booster Pump P101 at MCC 100.
5. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 ON.
6. When station suction pressure decreases and alarm condition no longer exists.
7. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
### AUTO (PRESSURE SWITCH CONTROL) OPERATION

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.
2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.
3. Confirm AUTO position status indication (YIA 101A) at HSQ/RTU and CCS.
5. Confirm local RUN indication (YLR 101) at MCC 100.
6. Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.
7. Confirm local ETM (KI 101) increases at MCC 100.
8. Confirm local motor amperage indication (II 101) for each phase at MCC 100.
9. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.

### High Pump Discharge Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.
2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.
3. Confirm Booster Pump P 101 is ON.
5. Pressure switch (PSH 101) setpoint pressure. Note: For testing purposes adjust PSH 101 setpoint so that pump
7. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100.
8. Confirm local HIGH pump discharge pressure alarm indication (YLA 101A) at HSQ/RTU.
9. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS.
10. OPEN Booster Pump P 101 isolation valve (0038864).
11. Enable local alarm reset pushbutton (HMS 101C) for Booster Pump P101 at MCC 100.
12. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100 is OFF.
13. Confirm local HIGH pump discharge pressure alarm indication (YLA 101A) at HSQ/RTU is OFF.
14. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS is OFF.
15. Confirm Booster Pump P 101 starts.
16. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
<table>
<thead>
<tr>
<th></th>
<th>Low Station Suction Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.</td>
</tr>
<tr>
<td>2</td>
<td>Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>4</td>
<td>Alarm setpoint (PSL 115). Monitor pressure indicator PI 135 to decrease pressure to reach the low station suction</td>
</tr>
<tr>
<td>5</td>
<td>Confirm Booster Pump P 101 is OFF.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>8</td>
<td>Simulate Normal Booster Station Suction Pressure condition.</td>
</tr>
<tr>
<td>9</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.</td>
</tr>
<tr>
<td>10</td>
<td>Enable local low Station Suction Pressure alarm reset pushbutton (HMS 115) at PNL 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.</td>
</tr>
<tr>
<td>12</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.</td>
</tr>
<tr>
<td>13</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>14</td>
<td>Alarm setpoint (PSL 115). Monitor pressure indicator PI 135 to decrease pressure to reach the low station suction</td>
</tr>
<tr>
<td>15</td>
<td>Confirm Booster Pump P 101 is OFF.</td>
</tr>
<tr>
<td>16</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.</td>
</tr>
<tr>
<td>17</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>18</td>
<td>Simulate Normal Booster Station Suction Pressure condition.</td>
</tr>
<tr>
<td>19</td>
<td>Enable Low Station Suction Pressure alarm reset (YCR 115) at CCS.</td>
</tr>
<tr>
<td>20</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.</td>
</tr>
<tr>
<td>21</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.</td>
</tr>
<tr>
<td>22</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>23</td>
<td>Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.</td>
</tr>
</tbody>
</table>
1. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.
2. Confirm Booster Pump P 101 is ON.
3. Confirm high station discharge pressure indication (PAH 110) at HSQ/RTU and CCS.
4. Enable local high station discharge pressure alarm reset pushbutton (HMS 110) at PNL 100.
5. Confirm Booster Pump P 101 is ON.
6. Confirm high station discharge pressure indication (PAH 110) at HSQ/RTU and CCS.
7. Confirm high station discharge pressure alarm (PAH 110).
8. Enable local high station discharge pressure alarm reset pushbutton (HMS 110) at PNL 100.
9. Confirm Booster Pump P 101 is ON.
10. Confirm local high station discharge pressure alarm indication (YLA 110) is OFF at PNL 100.
11. Confirm high station discharge pressure alarm indication (PAH 110) is OFF at CCS.
12. Confirm high station discharge pressure alarm (PAH 110).
13. Confirm Booster Pump P 101 is OFF.
14. Confirm local high station discharge pressure alarm indication (YLA 110) at PNL 100.
15. Confirm high station discharge pressure indication (PAH 110) at HSQ/RTU and CCS.
16. Confirm high station discharge pressure alarm (PAH 110).
17. Enable high station discharge pressure alarm reset pushbutton (YCR 110) at CCS.
18. Confirm local high station discharge pressure alarm indication (YLA 110) is OFF at PNL 100.
19. Confirm high station discharge pressure alarm indication (PAH 110) is OFF at CCS.
20. Confirm Booster Pump P 101 is ON.
21. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
**High Station Suction Pressure**

1. Alarm setpoint (PSH 115).
2. Confirm High Station Suction Pressure Alarm indication (PAH 115) at HSQ/RTU and CCS.
3. Place Booster Pump P 101 HOAR selector switch in AUTO (pressure Switch Control) at MCC 100.
4. Confirm Booster Pump P 101 is ON.
5. 101 running.
6. When discharge pressure decreases and alarm condition no longer exists.
7. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.

**REMOTE (HSQ/RTU CCS CONTROL) OPERATION**

1. Confirm HSQ/RTU OK output.
2. 101 running.
3. Place Booster Pump P 101 HOAR selector switch in REMOTE (HSQ/RTU CCS Control) at MCC 100.
4. Confirm REMOTE position status indication (Y1A 101C) at HSQ/RTU and CCS.
5. Confirm Booster Pump P 101 starts.
6. Confirm HSQ START command is enabled. Confirm local RUN indication (YL 101) at MCC 100.
7. Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.
8. Confirm local ETM (KI 101) increases at MCC 100.
9. Confirm local motor amperage indication (II 101) for each phase at MCC 100.
10. Pump P 101 to STOP.
11. Confirm HSQ STOP command is enabled.
Section 6 | Demonstration Test
Section 6: Demonstration Testing

Details: Demonstration Test is 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.

A Test Setup form shall be completed for each test which tells how the system will be operated during testing. Defining test configurations, temporary connections, and bypass connections. Test Setup form also informs every one how much waste there will be and the approximate test duration, plus shows who will be involved in the testing to ensure all parties are present. Lastly, the form can be utilized to detail why a scenario or equipment cannot be tested due to process demands or unattainable configurations.

Demonstration Testing plan should be developed to show step-by-step details that demonstrates the operation of the system as designed. 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. The Demonstration Testing can only start after all Verification Test groups are completed by the Contractor. To verify all pre-activities are complete, the following Pre Demonstration Test Check list will need to be complete. The Contractor and Subcontractors will perform the testing for the Owner Representative, Owner, and Engineer.

**During this testing the Contractor, Subcontractors, Owner Representative, and Owner will be involved at minimum.

<table>
<thead>
<tr>
<th>Test Grp.</th>
<th>Description</th>
<th>Q.C. Initial / Date</th>
<th>Owner Rep. Initial / Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre Verification Check list complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>All Verification Test Tasks complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>All O&amp;M Manuals Pre Approved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>City has been notified of testing activities **days in advance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>All Bac’t tests complete and passed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>All pipe pressure tests complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>All temporary connections and equipment in place for testing as detailed in Section 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Items to be included in the Demonstration section:

1. Demonstration Test Setup Form
2. Demonstration Test Plan
### Test Setup

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>MCC and Pump P101</td>
</tr>
</tbody>
</table>

**Test System Group:**

- E - Suction Hydropneumatic Tank T-140 and
- Air Compressor 1 C-140

**Detailed Test Configuration, temporary connections, and bypass:**

The hydropneumatic tank will initially be filled with water to about half of the tank, then pressure will be manually added from the compressor to get to pressure about 25 psi. From there, the pressure and level indicators can be verified.

Then the probe well will be isolated and the water level changed to simulate conditions and verify control.

**Est. Duration (hr):** 4 hours  
**Est. Flow / Usage (gal):** 2000 gal

**System Limitation:**

All components can be tested.

### Required Personnel to Complete Testing:

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By:** Name and Company

**See attached Test System Layout for a list of items being tested**
## Demonstration Test Plan

<table>
<thead>
<tr>
<th>Completed test objective Sign off:</th>
<th>Associated Tasks</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>Owner Representative</td>
<td>Owner</td>
</tr>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td>Verified</td>
</tr>
<tr>
<td>B</td>
<td>AUTOMATIC OPERATION</td>
<td>Confirm Hand-Off-Auto (HOA) selector switch for air compressor is OFF at motor control center, MCC 100.</td>
</tr>
<tr>
<td>C</td>
<td>High Air Pressure</td>
<td>Raise water level in Suction Hydropneumatic Tank T 140 to above LSHH #140</td>
</tr>
<tr>
<td>D</td>
<td>Motor Overload</td>
<td>Place Hand-Off-Auto (HOA) selector switch for air compressor in AUTO at motor control center, MCC 100.</td>
</tr>
<tr>
<td>E</td>
<td>Low Lube Oil Level</td>
<td>Confirm air compressor starts.</td>
</tr>
<tr>
<td>F</td>
<td>Suction Hydropneumatic Tank Water Level High High (LSHH #140)</td>
<td>Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.</td>
</tr>
<tr>
<td>G</td>
<td>Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)</td>
<td>Confirm local RUN indication (YL 140) at MCC 100.</td>
</tr>
<tr>
<td>H</td>
<td>Low Booster Station Suction Pressure (PSL #115)- Local Reset</td>
<td>Confirm RUN indication (YIR 140) at HSO/RTU and CCS.</td>
</tr>
<tr>
<td>I</td>
<td>Low Booster Station Suction Pressure (PSL #115)- CCS Reset</td>
<td>Confirm local ETM (KI 140) increases at MCC 100.</td>
</tr>
</tbody>
</table>

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

---

**Test Plan:**

**Task #** | Task Description | Comments
---|---|---
A | Pre-Test Checks |
| 1 | All Contractor starting and placing equipment in operation and equipment and system startup are to be complete prior to start of Testing. |
| 2 | Verification of calibration and pump capacities is to be complete prior to start of final operational |
| 3 | Contractor shall ensure all valve open-close positions are correct prior to starting each test below. |

**B** | AUTOMATIC OPERATION |
---|---

---

**References:**

- City of Phoenix WATER SERVICES DEPARTMENT
- Page 4  Section 6 Demonstration Test
### C High Air Pressure

1. Close shutoff valve in air compressor discharge line at hydropneumatic tank.

2. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.

3. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.

4. Confirm air compressor starts and then STOPS after time delay TDR1.

5. Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.

6. Confirm local HIGH air pressure alarm indication (YA 140C) at MCC 100.

7. Confirm HIGH air pressure alarm indication (PAR 140) at HSQ/RTU.

8. Confirm Air Compressor 1 General Trouble alarm indication at CCS.

9. Open shutoff valve and clear high pressure air condition.

10. Enable local High Pressure alarm reset push button (HMS 140A) at MCC 100.

11. Confirm local High Pressure alarm indication (YA 140C) is OFF at MCC100.

12. Confirm HIGH air pressure alarm indication (PAR 140) at HSQ/RTU automatically resets and is OFF.

13. Confirm Air Compressor 1 General Trouble alarm indication at CCS automatically resets and is OFF.

14. If necessary, raise water level in Suction Hydropneumatic Tank T 140 to above LSH140.

15. Confirm air compressor starts.

16. Confirm solenoid valve SV-140 on air line to Suction Hydropneumatic Tank T 140 remains open.

### D Motor Overload

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.

2. Trip motor overload at MCC 100.

3. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.

4. Confirm air compressor does NOT start.

5. Confirm local Air Compressor 1 Failure alarm indication (YA 140B) at MCC 100.

6. Confirm Air Compressor 1 Failure alarm indication (YA 140B) at HSQ/RTU.

7. Confirm Air Compressor Failure alarm indication (YA 140B) at CCS.

8. Reset motor overload.

9. Enable local Air Compressor 1 Failure alarm reset push button (HMS 140A) at MCC 100.

   Confirm local Air Compressor 1 Failure alarm indication (YA 140C) is OFF at MCC 100.

   Confirm Air Compressor 1 Failure alarm indication (YA 140) at HSQ/RTU automatically resets and is OFF.

   Confirm Air Compressor 1 General Trouble alarm indication) at CCS automatically resets and is OFF.

   Confirm air compressor starts.
### E Low Lube Oil Level

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Simulate a low lube oil level alarm.
3. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
4. Confirm air compressor does NOT start.
5. Confirm local Air Compressor 1 Low Lube Oil Alarm indication (YA 140A) at MCC 100.
6. Confirm Air Compressor 1 Low Lube Oil alarm indication (YA 140A) at HSQ/RTU.
7. Confirm Air Compressor 1 General Trouble alarm indication at CCS.
8. Clear simulated low lube oil level condition.
9. Enable local Air Compressor 1 Low Lube Oil alarm reset push button - (HMS 140A) at MCC 100.
10. Confirm local Air Compressor 1 Low Lube Oil alarm indication (YLA 140A) is OFF at MCC 100.
11. Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
12. Confirm air compressor starts.

### F Suction Hydropneumatic Tank Water Level High High (LSHH #140)

Raise water level in Suction Hydropneumatic Tank T 140 to above LSHH 140. This could allow air out of hydropneumatic tank.

- Confirm Suction Hydropneumatic Tank Water Level High alarm indication (LAHH 140) at HSQ/RTU and CCS.
- Confirm Hand-Off-Auto (HOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
- Lower water level in suction hydropneumatic tank to below LSHH 140.
- CCS automatically reset and are OFF.

### G Suction Hydropneumatic Tank Water Level Low Low (LSLL #140)

Lower water level in suction hydropneumatic tank to reach LSLL 140.

- Confirm Suction Hydropneumatic Tank Water Level Low Low alarm indication (LALL 140) at HSQ/RTU and CCS.
- Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
- Confirm air compressor will NOT start.
- Raise water level in suction hydropneumatic tank to above LSH 140.
- CCS automatically reset and are OFF.
- Confirm air compressor starts.
### H Low Booster Station Suction Pressure (PSL #115)- Local Reset

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
3. Confirm air compressor starts.
4. Simulate Low Booster Station Suction Pressure (PSL 115).
5. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
6. Confirm air compressor stops.
7. Clear simulated Low Booster Station Suction Pressure (PSL 115) condition.
8. Enable local alarm reset push button at PNL 100 at MCC 100.
9. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at PNL J00 at MCC J00.
10. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) resets at HSQ/RTU and CCS.
11. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
12. Confirm air compressor starts.

### I Low Booster Station Suction Pressure (PSL #115)- CCS Reset

1. Raise water level in Suction Hydropneumatic Tank T 140 to above LSH 140.
2. Confirm Hand-Off-Auto (BOA) selector switch for air compressor is in AUTO at motor control center, MCC 100.
3. Confirm air compressor starts.
4. Simulate Low Booster Station Suction Pressure (PSL 115).
5. Confirm Low Booster Station Suction Pressure (PSL 115) alarm indication (PAL 115) at HSQ/RTU and CCS.
6. Confirm air compressor stops.
**Test Setup**

<table>
<thead>
<tr>
<th>Project:</th>
<th>Sample</th>
<th>Location:</th>
<th>MCC and Pump P101</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test System Group:</strong></td>
<td>F - Booster Pump P 101</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Detailed Test Configuration, temporary connections, and bypass:**

(1) 4” HDPE temporary piping will be run from the pump discharge header to the drainage area to the south of the site. The temporary piping will be connected at the 90 degree fitting just prior to the 4in PD going underground. The temporary piping will be routed south along the east fence and a small hole will be dug to go under the chain link fence and into the drainage area.

<table>
<thead>
<tr>
<th>Est. Duration (hr):</th>
<th>3 hours</th>
<th>Est. Flow / Usage (mgd):</th>
<th>0.25</th>
</tr>
</thead>
</table>

**System Limitation:**

A maximum of 1ft of discharge will be allow to develop during testing in the drainage area.

**Required Personnel to Complete Testing:**

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

**Prepared By:** Name and Company

**See attached Test System Layout for a list of items being tested**
### Demonstration Test Plan

<table>
<thead>
<tr>
<th>Project: Sample</th>
<th>Equipment/System Name: Pump #101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Reference Drawing: I008</td>
</tr>
</tbody>
</table>

**Test Group: F - Booster Pump P 101**

<table>
<thead>
<tr>
<th>Associated Tasks</th>
<th>Description</th>
<th>Contractor</th>
<th>Owner Representative</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre-Test Checks</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>AUTO (PRESSURE SWITCH CONTROL) OPERATION</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>High Pump Discharge Pressure</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Low Station Suction Pressure</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Low Station Discharge Pressure</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>High Station Discharge Pressure</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>High Station Suction Pressure</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>REMOTE (HSQ/RTU CCS CONTROL) OPERATION</td>
<td>Verified</td>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>

**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 Checks</td>
<td></td>
</tr>
</tbody>
</table>

1. All Contractor starting and placing equipment in operation and equipment and system startup are to
2. Verification of calibration and pump capacities is to be complete prior to start of final operational
3. Contractor shall ensure all valve open-dose positions are correct prior to starting each test below.

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>AUTO (PRESSURE SWITCH CONTROL) OPERATION</td>
<td></td>
</tr>
</tbody>
</table>

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.
2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.
3. Confirm AUTO position status indication (Y1A 101A) at HSQ/RTU and CCS.
5. Confirm local RUN indication (Y1.101) at MCC 100.
6. Confirm RUN indication (YIR 101) at HSQ/RTU and CCS.
7. Confirm local ETM (KI 101) increases at MCC 100.
8. Confirm local motor amperage indication (II 101) for each phase at MCC 100.
9. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
### C High Pump Discharge Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.

2. Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.

3. Confirm Booster Pump P 101 is ON.


5. Confirm Booster Pump P 101 STOPS after time set for TDR-1.

6. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100.

7. Confirm local HIGH pump discharge pressure alarm indication (YLA 101A) at HSQ/RTU.

8. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS.


10. Enable local alarm reset pushbutton (HMS 101C) for Booster Pump A101 at MCC 100.

11. Confirm local HIGH pump discharge pressure alarm indication (YLA 101) at MCC 100 is OFF.

12. Confirm local HIGH pump discharge pressure alarm indication (YLA 101A) at HSQ/RTU is OFF.

13. Confirm Booster Pump P 101 General Trouble alarm (YA 101A) at CCS is OFF.

14. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
## D Low Station Suction Pressure

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that keeps Booster Pump P 101 running.</td>
</tr>
<tr>
<td>2</td>
<td>Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>4</td>
<td>Alarm setpoint (PSL 115). Monitor pressure indicator PI 135 to decrease pressure to reach the low station suction.</td>
</tr>
<tr>
<td>5</td>
<td>Confirm Booster Pump P 101 is OFF.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>8</td>
<td>Simulate Normal Booster Station Suction Pressure condition.</td>
</tr>
<tr>
<td>9</td>
<td>Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.</td>
</tr>
<tr>
<td>10</td>
<td>Enable local low Station Suction Pressure alarm reset pushbutton (HMS 115) at PNL 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.</td>
</tr>
<tr>
<td>12</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.</td>
</tr>
<tr>
<td>13</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>14</td>
<td>Alarm setpoint (PSL 115). Monitor pressure indicator PI 135 to decrease pressure to reach the low station suction.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm Booster Pump P 101 is OFF.</td>
</tr>
<tr>
<td>16</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100.</td>
</tr>
<tr>
<td>17</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>18</td>
<td>Simulate Normal Booster Station Suction Pressure condition.</td>
</tr>
<tr>
<td>19</td>
<td>Enable Low Station Suction Pressure alarm reset (YCR 115) at CCS.</td>
</tr>
<tr>
<td>20</td>
<td>Confirm local Low Station Suction Pressure alarm indication (PAL 115) at PNL 100 is OFF.</td>
</tr>
<tr>
<td>21</td>
<td>Confirm Low Station Suction pressure alarm indication (PAL 115) at HSQ/RTU and CCS is OFF.</td>
</tr>
<tr>
<td>22</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>23</td>
<td>Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.</td>
</tr>
</tbody>
</table>
### E Low Station Discharge Pressure

1. Adjust throttling valve on temporary booster station discharge pipe to a flowrate that will keep Booster Pump P 101 running.
2. Place Booster Pump P 101 HOAR selector switch in AUTO (pressure Switch Control) at MCC 100.
3. Confirm Booster Pump P 101 is ON.
4. Temporarily adjust setpoint of PAL 150 as needed to avoid pump from running too far to the right of its pump curve.
5. (YLA 150) at PNL 100.
6. Confirm Booster Pump P 101 is ON.
7. Confirm low Station Discharge Pressure indication (PAL150) at HSQ/RTU and CCS.
8. Pump P 101 capacity and increases pressure not causing a Low Station Discharge Pressure alarm (PAL 150).
9. Enable local Low Station Discharge Pressure alarm reset pushbutton I (HMS 150) at PNL 100.
10. Confirm Booster Pump P 101 is ON.
11. Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.
12. Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.
13. 101 capacity and decreases pressure causing a Low Station Discharge Pressure alarm (PAL 150).
14. Confirm Booster Pump P 101 is ON.
15. Confirm local Low Station Discharge Pressure alarm indication (PAL 150) at PNL 100.
16. Confirm Low Station Discharge Pressure indication (PAL 150) at HSQ/RTU and CCS.
17. Pump P 101 capacity and increases pressure not causing a Low Station Discharge Pressure alarm (PAL 150).
18. Enable Low Station Discharge Pressure alarm reset pushbutton (YCR 150) at CCS.
19. Confirm Booster Pump P 101 is ON.
20. Confirm local Low Station Discharge Pressure alarm indication (YLA 150) is OFF at PNL 100.
21. Confirm Low Station Discharge Pressure alarm indication (PAL 150) is OFF at CCS.
22. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.
<table>
<thead>
<tr>
<th>Step</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>101 running.</td>
</tr>
<tr>
<td>2</td>
<td>Place Booster Pump P 101 HOAR selector switch in AUTO (Pressure Switch Control) at MCC 100.</td>
</tr>
<tr>
<td>3</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>4</td>
<td>Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>5</td>
<td>Confirm High Station Discharge Pressure indication (PAH110) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>6</td>
<td>Confirm local High Station Discharge Pressure alarm reset pushbutton (HMS 110) at PNL 100.</td>
</tr>
<tr>
<td>7</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>8</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.</td>
</tr>
<tr>
<td>9</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>10</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.</td>
</tr>
<tr>
<td>11</td>
<td>Confirm High Station Discharge Pressure alarm indication (PAH 110) is OFF at CCS.</td>
</tr>
<tr>
<td>12</td>
<td>Confirm High Station Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>13</td>
<td>Confirm Booster Pump P 101 is OFF.</td>
</tr>
<tr>
<td>14</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) at PNL 100.</td>
</tr>
<tr>
<td>15</td>
<td>Confirm High Station Discharge Pressure alarm indication (PAH 110) at HSQ/RTU and CCS.</td>
</tr>
<tr>
<td>16</td>
<td>Confirm High Station Discharge Pressure alarm (PAH 110).</td>
</tr>
<tr>
<td>17</td>
<td>Enable High Station Discharge Pressure alarm reset pushbutton (YCR 110) at CCS.</td>
</tr>
<tr>
<td>18</td>
<td>Confirm local High Station Discharge Pressure alarm indication (YLA 110) is OFF at PNL 100.</td>
</tr>
<tr>
<td>19</td>
<td>Confirm High Station Discharge Pressure alarm indication (PAH 110) is OFF at CCS.</td>
</tr>
<tr>
<td>20</td>
<td>Confirm Booster Pump P 101 is ON.</td>
</tr>
<tr>
<td>21</td>
<td>Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.</td>
</tr>
</tbody>
</table>
**G High Station Suction Pressure**

1. Alarm setpoint (PSH 115).
2. Confirm High Station Suction Pressure Alarm indication (PAH 115) at HSQ/RTU and CCS.
3. Place Booster Pump P 101 HOAR selector switch in AUTO (pressure Switch Control) at MCC 100.
4. Confirm Booster Pump P 101 is ON.
5. 101 running.
6. when discharge pressure decreases and alarm condition no longer exists.
7. Place Booster Pump P 101 HOAR selector switch in OFF at MCC 100.

**H REMOTE (HSQ/RTU CCS CONTROL) OPERATION**

1. Confirm HSQ/RTU OK output.
2. 101 running.
3. Place Booster Pump P 101 HOAR selector switch in REMOTE (HSQ/RTU CCS Control) at MCC 100.
4. Confirm REMOTE position status indication (Y1A 101C) at HSQ/RTU and CCS.
5. Confirm Booster Pump P 101 starts.
6. Confirm HSQ START command is enabled. Confirm local RUN indication (Y1 101) at MCC 100.
7. Confirm RUN indication (Y1R 101) at HSQ/RTU and CCS.
8. Confirm local ETM (KI 101) increases at MCC 100.
9. Confirm local motor amperage indication (II 101) for each phase at MCC 100.
10. Pump P 101 to STOP.
11. Confirm HSQ STOP command is enabled.
Section 7  |  Commissioning
Section 7: Commissioning

Details: Commissioning is the sequential process in which a newly constructed facility is put into successful operation, refer to specification section 01810. The goal is to allow the completed system to operate, over a specified time period, as designed with no deficiencies when intergraded into the Owner’s system. This section will include details how the Contractor will bring the system on line and monitored over the testing period.

The Commissioning can only start after all Demonstration Tests are completed by the Contractor. To verify all pre-activities are complete the following PreCommissioning Test Check list will need to be complete.

Secondly this section will allow the Owner to discuss any system or configuration testing on the new equipment or testing in conjunction with other systems. The Owner shall provide a Test Plan so the contractor is made aware of the tasks the Owner will be performing.

Pre Commissioning Test Check List

<table>
<thead>
<tr>
<th>Description</th>
<th>Q.C. Initial / Date</th>
<th>Owner Rep. Initial / Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Demonstration Check list complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Demonstration Test Objectives complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City has been notified of testing activities **days in advance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All permanent connections complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All training complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All O&amp;M’s submitted and approved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All spare parts delivered</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Items to be included in the Commissioning section:

1. Commissioning Specific Emergency Contact List
2. Commissioning Test Setup
3. Commissioning Monitoring Form
4. Owner Commissioning Test Plan
Commissioning 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.

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company:</td>
<td>Affiliation:</td>
</tr>
<tr>
<td>Contact Information:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company:</td>
<td>Affiliation:</td>
</tr>
<tr>
<td>Contact Information:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<th>Name:</th>
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<tr>
<td>Company:</td>
<td>Affiliation:</td>
</tr>
<tr>
<td>Contact Information:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company:</td>
<td>Affiliation:</td>
</tr>
<tr>
<td>Contact Information:</td>
<td></td>
</tr>
</tbody>
</table>
**Commissioning Test Setup**

**Project:** Sample

<table>
<thead>
<tr>
<th>Detailed Test Configuration, temporary connections, and bypass:</th>
</tr>
</thead>
<tbody>
<tr>
<td>All permanent connections are made to the system. The site is fully complete as designed. Process chemicals are in place and/or filled.</td>
</tr>
<tr>
<td>The new system will be brought on line with the assistance of the owner to operate existing valves.</td>
</tr>
<tr>
<td>The Startup team will verify operation for a point of 4 hours after initial testing then the system will be allow to operate in automatic.</td>
</tr>
<tr>
<td>At this time the owner will be responsible for operation and the Startup team will be available for assistance as needed.</td>
</tr>
</tbody>
</table>

**Est. Duration (hr):** 72 hours  
**Est. Flow / Usage (Mgd):** 1.25 (as system demands)

**System Limitation:** All components can be operated.

**Required Personnel to Complete Testing:**

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Construction Manager:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Contractor:</td>
<td>Inspector:</td>
</tr>
<tr>
<td>Programmer:</td>
<td>Safety Personnel:</td>
</tr>
<tr>
<td>Owner's Staff:</td>
<td>Mechanical Contractor:</td>
</tr>
<tr>
<td>Engineer:</td>
<td>Quality Control Manager:</td>
</tr>
</tbody>
</table>

**Prepared By:** Name and Company

**See attached Test System Layout for a list of items being tested**
# Commissioning Checklist

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

**Name**  

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

<table>
<thead>
<tr>
<th><strong>Pump</strong></th>
<th>Pump #</th>
<th>AMPS</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
<th>YES/NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Check motor amperage</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>- Air relief valve leaking/unclean?</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>- Any leaking mechanical seals?</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>- Any abnormal vibration?</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>- Any abnormal noise?</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>- Liquid is flowing to the check valve cylinder?</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>- Elapsed time meter reading</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
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</tr>
<tr>
<td>- Pump control valve position?</td>
<td>Pump #</td>
<td></td>
<td>AMPS</td>
<td>YES/NO</td>
<td>YES/NO</td>
<td>YES/NO</td>
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</table>

**General Pump**  

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

- SCADA suction pressure reading | YES/NO |
- Suction pressure 50 - 55 psi? | YES/NO |
- SCADA discharge pressure reading | YES/NO |
- Discharge pressure 114 - 116 psi? | YES/NO |
- Any alarms on? If so, discuss why | YES/NO |
### Commissioning Checklist

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Field / SCADA</th>
</tr>
</thead>
<tbody>
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**Date & Time**

<table>
<thead>
<tr>
<th>Day of Commissioning Period</th>
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<table>
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<tr>
<th>Equipment Checks</th>
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<th>Comments / Issues</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

- Do SCADA readings match field readings?
  - YES/ NO

### Air Compressor

- Abnormal vibration?
  - YES/ NO
- Abnormal noise?
  - YES/ NO
- Check air intake filter
- Check the compressor and motor for lubrication
- Check oil level in bearings
- Check drive belt condition
- Elapsed time meter reading
  - _____ HOURS
- Excessive run time
  - YES/ NO
- Record air pressure
  - _____ PSI
- Any alarms on? If so, discuss why
  - YES/ NO
## Commissioning Checklist

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

<table>
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<th>Equipment Checks</th>
<th>Checked</th>
<th>Comments / Issues</th>
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<tbody>
<tr>
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</tbody>
</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**
Owner Provided Commission Test Plan
Section 8: Schedule

Details: The schedule will be a detailed logic driven schedule defining activity dates and durations. Key items to be included in the Schedule: Startup meeting #1 at 35 percent of contract amount, meeting #2 at 50 percent of contract amount, meeting #3 at no later then 5 weeks prior to testing, final Startup plan package submission, final O&M manual submission, training, Verification testing, Demonstration testing, Engineer’s operational training, and Commissioning.

Items to be included in the Schedule section:

1. Schedule
2. Training Request Forms  REF: Spec 01331 – Form 01821-B
Appendix
Appendix

Details: All other documents pertinent to the equipment and system testing.

Items to be included in the Appendix section:

1. Definitions
Definitions:

1. **Narrative**: The overview is to give a general overview of the project, operation and testing goals. The narrative defines testing configurations highlighting temporary piping and connections. It is a general discussion on how the testing will be performed.

2. **Emergency Contact Information**: Defines in order the person that will need to be contracted to react to the situation.

3. **Test Groups**: These are groups of equipment and sub-systems that work together in normal operation and could be individually tested as a group. These groups will be tested in the Contractor's Functional Tests and Demonstration Testing.

4. **Calibration Log**: This is a log that confirms all instrumentation has been calibrated and can be tested or operated properly.

5. **Equipment and Instrumentation Checkout Log**: This is a log that confirms all specification and manufacture required testing is completed, and the equipment or instrument can be tested or operated properly.

6. **Manufacture/Equipment Specific Checks or Testing**: These are vendor or manufacture required or standardized checks to verify the equipment or instrument can be tested or operated properly.

7. **Contractor's Functional Tests for Sign-offs**: This is a list of tasks that the Contractor has completed and recorded to verify every function, on each piece of equipment, operates properly and each piece of equipment operates as designed.

8. **Verification Test Plan**: This shows and records every function, on each piece of equipment, operates properly and each piece of equipment operates as designed. The plan will clearly show every aspect of the system works in various conditions as designed.

9. **Demonstration Test Plan**: This shows and records the system as a whole operates properly, and each piece of equipment operates as designed in various operating conditions.

10. **Schedule**: Detailed logic driven schedule defining activity dates and durations.

11. **Test Setup Form**: This form tells how the system will be operated during testing. Defining test configurations, temporary connections, and bypass connections. This form also informs everyone how much waste there will be and the approximate test duration. Also shows who will be involved in the testing to ensure all parties are present. Lastly, the form details why a scenario or equipment cannot be tested due to process demands or unattainable configurations.

12. **Meeting #1**: The first meeting is to be held at approximately 35 percent work in place. It is to be an introduction of the project team. The Contractor is to provide a preliminary testing plan, schedule, and define the basic demonstration test configurations. The Contractor will also define at this time any system limitations, new or existing. The project team will review the specifications and testing plan requirements. The Engineer will discuss an overview of the system operation.

13. **Meeting #2**: The second meeting is to be held at approximately 50 percent of work in place. The purpose of this meeting is for the project team to review the Contractor's plan and schedule. The Contractor shall provide six (6) copies of the plan and schedule/timeline for the project team's review. The Contractor is to revise and resubmit the testing plan for a final review two (2) weeks after the second meeting. The final plan should be submitted and approved no later than 70 percent of work in place.
14. **Meeting #3:** The third meeting is to be held no later than 5 weeks prior to testing. The purpose of this meeting is to review the approved plan and schedule. Also to confirm schedule dates with the Owner’s operators and discuss equipment readiness.

15. **Engineer's Operational Training:** Training provided by the engineer on how the overall system works. This task is after Demonstration testing prior to Commissioning.
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ATTACHMENT B
RESERVOIR DAM ASSESSMENT PROGRAM SPECIFICATIONS
(SEPARATE SUBMITTAL PREPARED BY OTHERS)
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CITY OF PHOENIX: Water Services Department
PROJECT NAME: Reservoir Landscape Master Plans
PROJECT NUMBER: WS85050042-4

100% SUBMITTAL
TECHNICAL SPECIFICATIONS

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FOR
CITY OF PHOENIX
RESERVOIR LANDSCAPE MASTER PLANS PROJECT
CITY PROJECT NO. WS85050042-4

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MARICOPA ASSOCIATION OF GOVERNMENTS (MAG)
UNIFORM STANDARD SPECIFICATIONS
441 Landscape Irrigation System Repair and Replacement
PROFESSIONAL SEALS
These technical specifications and related contract documents represent the combined efforts of the following professional consulting firms:

1. Environmental Planning Group, LLC
2. AMEC Environmental and Infrastructure, Inc.

A representative from each firm has affixed his/her seal below to attest that portions of these specifications and drawing sheets appearing above their seal were prepared under their direction.

Environmental Planning Group, LLC
Specification Sections 01110, 01271, 01320, 01721, 02220, 02230, 02318, 02901, 02921, 03305, 03930, MAG 441
Drawing Sheets G-01, G-02, G-03, L-01 – L-07, L-08

AMEC Environmental and Infrastructure, Inc.
Specification Sections 01451, 02230, 02315, 02319, 02371
Drawing Sheets G-03, L-01 – L-07 (tree removal and tree cutting notes only), L-09

EPG Project # COP 0009
PART 1 - GENERAL

1.1 LOCATION AND DESCRIPTION OF WORK

A. The Work is located at the following four (4) sites:
   • On the site of the 24th Street Reservoir (1-ES2), 24th Street and Arizona
     Biltmore Circle in Phoenix, Arizona.
   • On the site of the South Mountain Reservoir (1-ES3) at the southwest
     intersection of Elliot Road and 27th Avenue, in Phoenix, Arizona.
   • On the site of the Shadow Mountain Reservoir (4A-ES3) on Cave Creek Road
     north of Hearn Road, in Phoenix, Arizona.
   • On the site of the 64th Street Reservoir (1-ES1), accessed off of 62nd Street
     south of Thomas Road, in Scottsdale, Arizona.

B. The Contract Documents include the following:
   • Volume 1 of 2 Divisions 0 Through 3 Specifications
   • Volume 2 of 2 Drawings

C. The Contract Documents for the Work to be performed include the following, but are
   not limited to:
   1. The cutting or removal of trees and some deep-rooted shrubs from the
      embankments of the four reservoir sites to FEMA 534 standards.
   2. Restoration of the embankment structural fill.
   3. Clearing and repair of existing drainage facilities at the Shadow Mountain and
      South Mountain sites.
   4. Erosion repairs at the Shadow Mountain site.
   5. Placement of rock mulch and hydroseed on the Shadow Mountain and South
      Mountain embankments following tree removal and structural fill restoration.
   6. BID ALTERNATES for the 24th site to accomplish one of the following:
      a. Protect and refill existing planters with coarse drain aggregate.
      b. Demolish existing planters and construct gunite embankment
         covering to match existing.
      c. Protect existing planters and replant with shallow-rooted
         vegetation.

D.

1.2 CONTRACT

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

B. OWNER’S Responsibilities:
1. The OWNER will, through the ENGINEER, employ and pay for an independent testing laboratory to perform the specified services.

C. CONTRACTOR’S Responsibilities:
   1. Responsibilities for equipment and materials delivered to the project site will begin on CONTRACTOR’s acceptance of the equipment and materials at the location.
   2. Receive and unload equipment and materials at site. Provide labor and equipment for unloading. Perform unloading promptly. Charges for demurrage due to negligence of delay shall be paid by CONTRACTOR.
   3. Inspect for completeness or damage, jointly with OWNER, and reject defective items. OWNER, however, reserves the right to accept items rejected by the CONTRACTOR and to authorize their use in the Work.
   4. Indicate to Owner signed acceptance of delivery on a copy of the shipping invoice.
   5. Handle, store, and maintain equipment and materials.
   6. Repair or replace equipment and material which are missing or lost or are damaged after receipt. Replacement shall conform to the OWNER’s original procurement specifications.

1.3 SEQUENCE AND PROGRESS OF WORK

A. Submit a Construction Schedule covering the entire Work in accordance with Section 01320, Progress Schedule.

B. 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.

1.4 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.

1.5 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.

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 three (3) working days 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: Adam Zendejas, phone number: (602)262-4983.

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 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, plant services, CONTRACTOR’S or ENGINEER’S field offices, layout surveys, job signs, sanitary requirements, testing, safety devices, approval and Record Drawings, water supplies, power, traffic maintenance, removal of waste, watchmen, bonds, insurance, or all other requirements of the General Conditions, Supplementary Conditions, and the Contract Requirements. 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.
1.4 GENERAL

A. Item 2.5.1 - All Work under the Bidding Documents, except those items listed separately below:
   1. Measurement and Payment: The lump sum payment for Item 2.5.1 will be full compensation for completing the Work, as shown and specified. Not included in Item 2.5.1 are Items 2.5.2 through 2.5.8.

B. Item 2.5.2 - For Mobilization Costs:
   1. Measurement and Payment: The lump sum payment for Item 2.5.2 will be full compensation for CONTRACTOR'S mobilization costs.

C. Item 2.5.3 - Allowance for Potholing, as directed by the ENGINEER:
   1. Measurement and Payment: The lump sum payment for Item 2.5.3 will be full compensation for all potholing, including excavation, backfill, and surface restoration, disposal of unsuitable material off-site, sheeting and shoring. The maximum payment made under Item 2.5.3 shall not exceed $500 for each pothole location, with a maximum of four locations.

D. Item 2.5.4 - Additional Excavation:
   1. Measurement: Additional excavation will be measured for payment on the basis of the lines and grades directed by ENGINEER, or as the volume within the limits described below, whichever is applicable.
      a. For excavation and backfilling for pipes, the trenches will be assumed to be of rectangular cross section having a width of 2-feet greater than the outside diameter of the pipe laid therein, exclusive of bells, branches, hubs, spurs or concrete cradles, and a depth from the surface of the ground, at the centerline of pipe, to the bottom of the pipe bedding, or a depth equal to the distance to rock, where rock is encountered at a depth less than 6-inches below the bottom of the pipe. Enlargements of trench, authorized by ENGINEER where necessary to facilitate the support of existing structures, or for other reasons, will be measured for payment to the limits excavated in accordance with orders.
      b. All excavation for structures or facilities other than pipe will be measured for payment to the subgrade directed for such excavation and, unless otherwise shown, to vertical planes one foot outside the foundation limits of the structure to be built therein.
      c. For test pits outside the structure excavation or trench, and for those within the prescribed limits, but necessarily refilled previous to the final excavation, and for all other excavation not included above, but required
for the Work, excavation shall be measured to the lines directed or approved.

d. Measurement of the actual quantities of materials will be made by ENGINEER. CONTRACTOR, at his expense, may verify quantities.

2. Payment: The unit price per cubic yard for Item 2.5.4 will be full compensation for providing all additional excavation complete as directed and not specifically included under other items or contracts.

E. Item 2.5.5 - Extra Select Backfill:
1. Definition: Select backfill in excess of that required for the Work shown, specified, or directed by ENGINEER to be furnished and placed by CONTRACTOR and which is derived from off-site sources, shall be classified as extra select backfill from off-site source.

2. Measurement: The quantity of extra select backfill, which will be included for payment under Item 2.5.5, will be the computed number of cubic yards placed within the limits directed by the ENGINEER. No payment will be made for select backfill used for refill when earth excavation is carried below the grades specified or directed, nor for select backfill used for controlling groundwater. The total quantity of extra select backfill to be paid for under Item 2.5.5 will be the computed amounts used to replace unsuitable material, to improve pipe bedding, and to increase the load carrying capacity of pipe as directed or approved by the ENGINEER.

3. Payment: The unit price per cubic yard for Item 2.5.5 will be full compensation for providing and placing all extra select backfill complete from off-site sources which is not shown or specified, but directed to be performed, in writing, by the ENGINEER.

F. Item 2.5.6 - Additional Type "1" Concrete:
1. Measurement: The quantity of additional Type "1" concrete which will be paid for is the volume of concrete, in cubic yards, not including reinforcing steel, actually placed within the limits specified or directed by ENGINEER. No concrete placed in structures or as shown or specified, which is paid for under other items, will be paid for under Item 2.5.6. Payment for additional reinforcing steel will be compensated for under Item 2.5.7.

2. Payment: The unit price per cubic yard for Item 2.5.6 will be full compensation for providing and placing all additional Type "1" concrete complete as specified or directed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)
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.

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 ++
PART 1 - GENERAL

1.1 DESCRIPTION

A. The OWNER will, through the ENGINEER, employ and pay for an independent testing laboratory to perform the specified services.

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

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

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

1.2 QUALIFICATIONS OF LABORATORY

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

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

A. The testing laboratory shall:
   1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
   2. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.
   3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies of Work that are observed during performance of services.
   4. Promptly submit five copies of reports of inspections and tests to ENGINEER, including:
      a. Date issued.
      b. Project title and number.
      c. Testing laboratory name and address.
      d. Date of inspection or sampling.
      e. Record of temperature and weather.
      f. Date of test.
      g. Identification of product and Specification Section.
      h. Location in Project.
      i. Type of inspection or test.
      j. Results of tests and observations regarding compliance with Contract Documents.
   5. Perform additional tests and services, as required by OWNER.

1.4 CONTRACTOR’S RESPONSIBILITIES

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+++ END OF SECTION +++
SECTION 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 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. At the direction of the Engineer, 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, Demolition, Section 02230, Clearing, Section 02318, Decomposed Granite, Section 02901, Landscaping, and 02921, Seeding.
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. Access to roofs is restricted; keep clear of existing roofs.

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 02220

DEMOLITIONS

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 concrete, masonry, and similar existing facilities.
   3. Demolitions and removals which may be specified under other Sections shall conform to requirements of this Section.
   4. Pay for all landfill disposal fees.

1.2 SUBMITTALS

A. Schedule: Submit for approval proposed methods, equipment, and operating sequences. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of OWNER’S operations.

1.3 JOB CONDITIONS

A. Protection:
   1. Perform all demolition and removal Work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
   2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.
   3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices.
   4. Repair damage to facilities to remain, or to any property belonging to the OWNER or occupants of the facilities. Comply with requirements of Section 02230, Clearing.

B. Scheduling:

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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.

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 exposed or modified 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.

F. Pavement Demolition:
   1. All 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, 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. 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.

3.5 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 surface or as otherwise approved by the ENGINEER. All repairs shall be finished to match existing, unless otherwise approved by the ENGINEER.

C. Openings in existing concrete slabs 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. 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, and Section 02230, Clearing.

++ END OF SECTION ++
PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to perform all clearing and grubbing as shown on the Drawings and specified.

B. The Work covered by this Section consists of removing and disposing of all designated trees, stumps, bush, roots, designated shrubs, vegetation, logs, rubbish, and other objectionable material from the site, as required to perform the Work.

1.2 QUALITY ASSURANCE

A. Codes and Standards: State and local laws and code requirements shall govern the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter.

1.3 JOB CONDITIONS

A. Protection:
   1. Streets, roads, adjacent property and other works and structures shall be protected throughout the entire Project. Return to original condition, satisfactory to the ENGINEER, damaged facilities caused by CONTRACTOR’S operations.

   2. Trees, shrubs, grassed and landscaped areas, which are to remain, shall be protected using methods approved by the ENGINEER. Equipment, stockpiles, etc. shall not be permitted within tree branch spread. Trees shall not be removed without approval of the ENGINEER, unless shown or specified.

1.4 GUARANTEE

A. Guarantee that Work performed under this Section will not permanently damage trees, shrubs, turf or plants designated to remain, or other adjacent work or facilities. If damage resulting from CONTRACTOR’S operations appears during the period up to 18 months after completion of the Project, replace damaged items, at no additional cost to OWNER.

PART 2 – PRODUCTS (NOT USED)
3.1 CLEARING AND GRUBBING

A. Limits of clearing shall be all areas within the contract limits. Damage outside these limits caused by CONTRACTOR’S operations shall be corrected at CONTRACTOR’S expense.

B. Remove from the site and legally dispose of all stumps, roots, brush, masonry, rubbish, scrap, debris, pavement, curbs, fences and miscellaneous other structures not covered under other Sections as shown on the Drawings, specified or otherwise required to permit construction of the Work. Comply with requirements of Section 02220, Demolitions. Remove trees and shrubs as directed by the Engineer in accordance with Part 3.2 of this Section.

C. No cleared or grubbed material may be used in backfills or structural embankments. Comply with requirements of Section 02315, Structural Excavation and Backfill.

D. Burning on the site will not be allowed.

E. In order to avoid additional removal or damage, existing trees and shrubs not designated for removal shall be trimmed as required to perform the Work. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty who are approved by ENGINEER. Trees and shrubs intended to remain, which are damaged beyond repair or removed, shall be replaced by CONTRACTOR at no additional cost to OWNER.

F. Control air pollution caused by dust and dirt, and complies with governing regulations.

3.2 Specifications for Tree Removal

The existing woody shrubs (bursage, creosote and brittlebush), unless otherwise indicated on the drawings, shall be protected to the greatest extent possible. The contractor shall take prudent actions to reduce disturbance to these plants during the work activities. Any damaged vegetation will be trimmed to remove the affected portion.

The trees designated for cutting, typically less than 6 inches in diameter, will be cut to the ground level, with no more than one inch of visible stump remaining. Coat the stump end with two coats of Eaton Chemical #9375 water based asphalt coating, applied by brush. Any alternative coatings proposed by the contractor must have a NSF 61 certification.

The trees designated for removal will be removed in general accordance with the following actions:

A. The canopy branches and trunk will be removed to approximately two feet above the ground, leaving a stump that can be used in the root ball removal process.
B. Remove the stump and root ball by pulling the stump, or by using a backhoe to first loosen the soils around the root ball, and then remove the stump and root ball together.

C. Do not remove any existing curbing, pavements or other improvements unless instructed by the Engineer.

D. Remove all of the remaining root system greater than 1-inch diameter (unless otherwise instructed by the Engineer) and all resulting loosened embankment soils by excavating the sides of the cavity to slopes no steeper than 1:1 (horizontal:vertical) and the bottom of the cavity approximately horizontal. Follow the excavation requirements of Section 02315 of these technical specifications.

E. Limit the depth of excavation to four feet. If the root ball and roots deeper than 4-foot cannot be fully removed within this depth, the project geotechnical engineer will visit the site and make a determination if excavation further than four feet in depth should be performed. A revised work plan will be developed, specific to those designated locations, and ADWR will be provided with a copy of the modified work plan. Excavations greater than four feet in depth will not be made until ADWR accepts the amended work plan.

F. All excavations will be performed in accordance with Arizona Division of Occupational Safety & Health and OSHA standards.

G. All debris resulting from the vegetation removal will be legally disposed off-site.

Backfill the excavation with compacted backfill, meeting the requirements of Section 02315 of the project technical specifications.
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 to complete the Work in every respect.
2. All temporary means required to prevent discharge of sediment to water courses from dewatering systems or erosion are included.
3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof, except rock.
4. On-site excavated material will be classified for use as backfill material. Excavation materials include all materials regardless of type, character, composition, moisture, or condition thereof.
5. Perform all earthwork as specified in this Section.

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 01451, Testing Laboratory Services Furnished by OWNER.
2. OWNER'S Testing Agency Scope:
   a. Test CONTRACTOR'S proposed materials in the laboratory and/or field for compliance with the Specifications.
   b. Perform field moisture content and density tests to assure that the specified compaction of backfill materials has been obtained.
   c. Report all test results to the ENGINEER and CONTRACTOR.
3. Authority and Duties of OWNER'S Testing Agency: Technicians representing the testing laboratory shall inspect the materials in the field and perform tests and shall report their findings to the ENGINEER and CONTRACTOR. When the materials furnished or Work performed fails to fulfill Specification requirements, the technician will direct the attention of the ENGINEER and CONTRACTOR to such failure.
   a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the
ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Contract Documents, nor to approve or accept any portion of the Work.

4. Responsibilities and Duties of CONTRACTOR:
   a. The use of testing services shall in no way relieve CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
   b. To facilitate testing services:
      1) Secure and deliver to the ENGINEER or to the testing agency, without cost, preliminary representative samples of the materials he proposes to use and which are required to be tested.
      2) Furnish such casual labor as is necessary to obtain and handle samples at the Work site or at other sources of material.
      3) Advise the OWNER'S testing agency at least two days in advance of any backfill operations to allow for completion of quality tests and for the assignment of personnel.
   c. OWNER'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 OWNER'S confirmation tests shall be not less than one on every compacted lift of fill or embankment material to finish grade.
   f. Copies of the test reports shall be submitted promptly to the ENGINEER.
   g. Demonstrate the adequacy of compaction equipment and procedures before exceeding placement of 10 cubic yards of compacted fill.
   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. If compaction fails to conform to the specified requirements, remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR'S confirmation tests to be performed in a manner acceptable to the ENGINEER. Frequency of confirmation tests for remedial Work shall be double that amount specified for initial confirmation tests.

B. Permits and Regulations:
1. Obtain all necessary permits for Work in roads, rights-of-way, railroads, etc. Also, obtain permits as required by local, state and federal agencies for discharging water from excavations.

2. Perform excavation Work in compliance with applicable requirements of governing authorities having jurisdiction.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 36, Specification for Structural Steel.
   2. D 422, Method for Particle-Size Analysis of Soils.
   4. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   10. 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 702, Base Materials, Section 725, Portland Cement Concrete. 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. 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.

1.4 JOB CONDITIONS
A. 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.

B. 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.

C. 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.

D. 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.

E. Dust Control: Contractor must obtain and abide by the terms of the Maricopa County Dust Control permit.

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 embankment and erosion repair material shall be stockpiled native sandy clay or granular soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 4-inches in size, nor have greater than 40 percent passing the 200 sieve. The maximum expansion of on-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
   2. Backfill and fill materials from off-site sources shall consist of silty or clayey sand soils which are uniformly mixed, contain no organic matter and which have a Plasticity Index less than ten. The maximum particle size of imported soils shall be 4-inches or less, if required to satisfy trenching, landscaping, or other requirements. The maximum expansion of off-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
   3. All materials for use as backfill and fill material shall be tested by the laboratory and approved by the ENGINEER.
   4. If on-site material is unsuitable as determined by the ENGINEER, select backfill or approved off-site fill shall be used.

PART 3 - EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavating, filling, and grading are to be performed. The CONTRACTOR to call for a final inspection by the ENGINEER of all components to be buried and comply with the inspection recommendations.
ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 SITE PREPARATION

A. Clear all areas to be occupied by permanent construction or embankments of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip subgrades for fills and embankments of vegetation, sod, topsoil and organic matter. All waste materials shall be removed from site and properly disposed of by CONTRACTOR. Burning is not be permitted. Refer to and comply with the requirements of Section 02230, Clearing.

3.3 TEST PITS

A. General:
   1. Excavate and backfill, in advance of the construction, test pits to determine conditions or location of the existing utilities and structures. Perform all Work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, backfilling and replacing pavement for the test pits.
      a. Responsibility for the definite location of each existing facility involved within the area of his excavation for Work under this Contract belongs to CONTRACTOR. Care shall be exercised during such location work to avoid damaging and/or disrupting the affected facility. Responsibility for repairing, at his expense, damage to any structure, piping, or utility caused by his Work, belongs to CONTRACTOR.

B. No separate payment will be made for test pits 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. When excavations are made below the required grades, without the written order of ENGINEER, they shall be backfilled as directed by ENGINEER, at the expense of CONTRACTOR.

C. 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.

D. 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 EROSION CONTROL

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.
   5. Remove only the designated vegetation. 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.

3.7 PLACEMENT OF FILL AND BACKFILL

A. General:
   1. All backfill required for embankments and required to provide the finished grades shown on the Drawings and as described herein shall be furnished, placed and compacted by CONTRACTOR.
   2. Backfill excavations as promptly as Work permits, but not until completion of the following:
      a. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
      b. 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 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 3.7.C., below.
   2. Fill around shall be deposited in layers not to exceed 6-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
Compaction of fill by inundation with water will not be prevented. Compaction of fill 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 3.7.C., below. Provide equipment capable of adding measured amounts of water to the fill 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 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. 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.

8. 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.

C. 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.

<table>
<thead>
<tr>
<th>Material Thick. (in)</th>
<th>Required Minimum Density-Percent Compaction (ASTM D 698)</th>
<th>Maximum Uncompacted Lift (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill</td>
<td>95</td>
<td>6</td>
</tr>
</tbody>
</table>

1. All fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±three percent.
2. Natural undisturbed soils or compacted soil subsequently disturbed or removed by construction operations shall be replaced with materials compacted as specified above.
3. OWNER’S testing service shall perform tests necessary to provide data for selection of fill material and control of placement water content.
4. Field density tests, to ensure that the specified density is being obtained, shall be performed by OWNER’S testing service during each day of compaction Work.
5. If the tests indicate unsatisfactory compaction, provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction Work shall be performed by CONTRACTOR, at no additional cost to the OWNER, until the specified compaction is obtained.
This Work shall include complete removal of unacceptable (as determined by the ENGINEER) fill areas and replacement and recompaction until acceptable fill is provided.

D. 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 3.7.C., above.

3.8 GRADING

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.

3.9 DISPOSAL OF EXCAVATED MATERIALS

Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away from the project site by CONTRACTOR and disposed of in compliance with ordinances, codes, laws and regulations at no additional cost to the OWNER. Refer to and comply with the requirements of Section 02230, Clearing.

3.10 RESTORING FACILITIES

A. Pavement, gutters, curbs, sidewalks or roadways disturbed or damaged by the CONTRACTOR'S operations 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.

++ END OF SECTION ++
SECTION 02318

ROCK MULCH, DRAIN ROCK AND DECORATIVE STONE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish, haul, prepare location to receive, and install rock mulch, drain rock and decorative stone 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 and the Drawings shall govern.

B. Sampling and sieve analysis shall be performed in accordance with ASTM D 75 and ASTM C 136.

1.3 SUBMITTALS

A. Submit for approval the following:
   1. Furnish representative samples of the rock mulch, course aggregate gravel, and decorative stone 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. Rock Mulch:
   1. Rock mulch shall be a graded material and shall be angular, free of calcareous coating, caliche, organic matter, or other foreign substances. Rock mulch shall meet the requirements of the MAG Uniform Standard Specifications 701, 702 and 703, and as modified in these Special Provisions.
2. The percentage wear of the material to be used as rock mulch will be determined by the test procedure of ASTM Standard C-131, Grading B. The percentage of wear of the material shall not exceed 40 after 500 revolutions.

3. The aggregates shall be well graded when tested in accordance with ASTM C-136 and ASTM C-117. The percentage composition by weight shall be within the following limits:

<table>
<thead>
<tr>
<th>TABLE 02318-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROCK MULCH GRADATION</td>
</tr>
<tr>
<td>Sieve</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>3 inch</td>
</tr>
<tr>
<td>2 inch</td>
</tr>
<tr>
<td>1 inch</td>
</tr>
</tbody>
</table>

The rock mulch shall be an integral color purchased in a quantity sufficient to complete the work from the same processing run. The design intent for the use of integral color rock mulch is to provide a surface treatment in a tone that is similar in color, tone and overall cast to the existing soils at the project site. The rock mulch is intended to blend, not contrast, the project into the surrounding landscape. The color to be used on each individual project shall be in the same color range as those materials found on site, and shall be approved by the OWNER and the ENGINEER. A one (1) ton sample of each rock mulch selected shall be provided by the CONTRACTOR and placed on site for approval prior to purchase of the rock mulch.

Rock mulch color for the Shadow Mountain site is to be ‘Tanner Gold’ by Granite Express or an approved equal.

Rock mulch color for the South Mountain site is to be ‘Express Gold’ by Granite Express or an approved equal.

B. Drain Rock:
1. Drain rock material shall be free of coatings, caliche, organix matter, and other foreign substances.
2. The drain rock material shall consist of coarse, hard, durable materials and shall meet the following grading requirements as determined by ASTM D422:

<table>
<thead>
<tr>
<th>TABLE 02318-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAIN ROCK GRADATION</td>
</tr>
<tr>
<td>Sieve Size (Square Openings)</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1-1/2 inch</td>
</tr>
<tr>
<td>1 inch</td>
</tr>
</tbody>
</table>
3. A quantity of sufficient size to have a dry weight of 15 pounds shall be selected and dried to constant weight at a temperature between 215°F and 230°F. Fifteen pounds of this material shall then be subjected to 500 revolutions in a Los Angeles abrasion machine, as described in Section 701, except that nothing shall be placed in the drum other than the material to be tested, and have the following results:

- Maximum loss of 9 percent at 100 revolutions
- Maximum loss of 40 percent at 500 revolutions

C. Decorative 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. Decorative stone shall be ½” screened, 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. The gradation shall be as shown below.

<table>
<thead>
<tr>
<th></th>
<th>25 - 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>½-inch</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0 - 5</td>
</tr>
<tr>
<td>No. 10</td>
<td>0 - 2</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.1 PLACING

A. After the erosion repairs are completed, the area has been cleared of debris, and hydroseed has been placed per Section 02921, the rock mulch shall be evenly distributed over the area with a minimum depth of four (4) inches. Finish grading will be accomplished and the granite will be lightly watered to an extent satisfactory to the Engineer.

B. Compaction of the drain rock shall not be required. However, the CONTRACTOR is responsible for selecting a placement procedure to achieve a firm and relatively unyielding condition as approved by the ENGINEER. Water settling or jetting shall not be permitted.
C. Decorative rock 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 02319

RIPRAP

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and place riprap at locations shown on the Drawings and specified.
   2. Any existing riprap removed shall be replaced by CONTRACTOR at no additional cost to the OWNER.

1.2 QUALITY ASSURANCE

A. Conform to all applicable requirements of Section 703 in the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. If there is a conflict between the MAG Standard Specifications, as supplemented by the City of Phoenix, and these Specifications, the provisions in these Specifications shall govern.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Stone for riprap shall be sound and durable, free from seams and coatings, and of such characteristics that it will not disintegrate when subjected to the action of water. Riprap stone should be of the same color, specified for each site, and tone as the rock mulch, per Section 02318 Rock Mulch.

B. Riprap stone shall be as large as can be conveniently placed in a layer of the required depth. The stones, excepting small stones and spalls used as chink interstices shall weigh not less than ten pounds and at least 50 percent of the stone shall not weigh less than 70 pounds.

C. Stones salvaged from excavation and meeting the above requirements may be used for riprap, if approved by the ENGINEER.

PART 3 - EXECUTION

3.1 PLACING

EPG Project # COP 0009 02319-1 2/28/14
A. Minimum total thickness of the riprap layer shall be 12-inches.

B. The stones shall be placed so that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest of stones shall be at the bottom. Riprap shall be of proper size to form a compact solid blanket to protect the slopes. Rounded boulders or cobbles shall not be used on slopes steeper than 2 to 1, unless grouted.

C. Riprap shall be placed so as to conform as closely as practicable in size and character to existing riprap, if applicable.

D. Riprap may be placed in location by equipment, however, care shall be taken in placing to obtain a good gradation of materials so that the riprap will be firm and solid. Surfaces shall be leveled to the required alignment and slopes by hand placing the stone so as to fill large voids and to make the surface even.

++ END OF SECTION ++
SECTION 02371

GEOTEXTILE FILTER FABRIC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and services required to provide and place geotextile fabric as shown on the Drawings and specified.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Geotextile manufacturer shall be a specialist in the manufacture of geotextile cushion fabric, and have produced and successfully produced a minimum of five million square feet.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's data, specifications, installation instructions and dimensions.
   2. Affidavit certifying that the filter fabric furnished complies with all requirements specified herein.
   3. No fabric shall be shipped until the affidavit is submitted to the ENGINEER.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Each roll of geotextile delivered to the site shall be labeled by the manufacturer identifying the manufacturer's name, product identification, lot number, roll number and roll dimensions.

B. All rolls and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to Geotextile Filter Fabric. Replace loss and repair damage to new condition, in accordance with manufacturer's instruction.

C. Geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

PART 2 - PRODUCTS
2.1 GEOTEXTILE FILTER FABRIC

A. Geotextile shall be a nonwoven fabric, suitable for reinforcement applications, composed of log-chain synthetic polymer composed of at least 85 percent by weight polyolefins, polyesters, or polamides. The fabric shall be inert to biological degradation and naturally encountered chemicals, alkalizes, and acids. Recycled or reclaimed fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. Geotextile shall equal or exceed the minimum average roll values listed per the following:

<table>
<thead>
<tr>
<th>Fabric Property</th>
<th>Unit</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>oz/yd²</td>
<td>ASTM D 5261</td>
<td>16.0</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>lb</td>
<td>ASTM D 4632</td>
<td>380</td>
</tr>
<tr>
<td>Grab Strength Elongation</td>
<td>%</td>
<td>ASTM D 4632</td>
<td>50</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>lb</td>
<td>ASTM D 4833</td>
<td>240</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>lb</td>
<td>ASTM D 4533</td>
<td>150</td>
</tr>
<tr>
<td>Wide Width Tensile Strength @ 5% strain</td>
<td>lb/in</td>
<td>ASTM D 4595</td>
<td>750</td>
</tr>
<tr>
<td>Water Permeability, &quot;k&quot;</td>
<td>cm/sec</td>
<td>CFMC GET-2</td>
<td>0.34</td>
</tr>
<tr>
<td>Water Flow Rate</td>
<td>gal/min/ft²</td>
<td>CFMC GET-2</td>
<td>80</td>
</tr>
</tbody>
</table>

B. Product and Manufacturer: Provide one of the following:
1. (--1--) as manufactured by Hoechst Corporation.
2. Or equal.

2.1 HARDWIRE CLOTH

A. Hardwire cloth shall be a welded wire fabric, composed of 0.063 inch diameter wire galvanized after weld, with 2 openings per inch.

B. Product and Manufacturer: Provide one of the following:
1. 2 Mesh 0.063” diameter wire square welded hardwire cloth (galvanized after weld) as manufactured by McNichols (p. 1.877.884.4653; f. 602.235.9734; address 5525 W. Latham St. No. 7, Phoenix, AZ 85043-1601)
2. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL
A. The geotextile shall be placed in the manner and at the locations designated on the plans or as identified by the ENGINEER. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

B. Take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

C. During placement of geotextiles, care shall be taken not to entrap in the geotextile stone, excessive dust, or moisture that could damage the geomembrane, generate clogging, or hamper subsequent seaming.

D. Geotextiles shall not be exposed to precipitation prior to being installed, and shall not be exposed to direct sunlight for more than 7 days. Failure to comply will result in the replacement of the geotextile. The Geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during installation or during placement of drain material or planter soil shall be replaced by the CONTRACTOR at no cost to the OWNER.

E. Geotextiles shall be overlapped 12-inches.

F. Geotextiles shall be secured to prevent movement prior to placement of any overlying material in a manner to be approved by the ENGINEER.

3.3 PLACEMENT OF COVER MATERIALS

A. Place all cover materials in such a manner to ensure: the geotextile is not damaged; minimal slippage of the geotextile on underlying layers; and no excess tensile stresses in the geotextile. Before placement of cover material, the CONTRACTOR shall demonstrate that the placement technique will not cause damage to the geotextile, to be approved by the ENGINEER.

++ END OF SECTION ++
PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all materials, equipment, labor, and incidentals required for the planting of ocotillo and ornamental grasses as shown on the Drawings and specified herein.
   2. All Work shall conform to the Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction, Section 430, Landscaping and Planting.
   3. Types of products required include the following:
      a. Ocotillo
      b. Ornamental grasses
      c. Fertilizers.
      d. Mulches and weed-control barriers.
      e. Accessories.

B. Coordination:
   1. Review the procedures described under the other Sections, and shall coordinate all Work required for the planting operation with that of other trades.

1.2 QUALITY ASSURANCE

A. A single firm specializing in landscape installation and maintenance, with the appropriate State of Arizona Contractor’s license in force, and a minimum of five years of experience in the type of Work described in this Section.

B. Assign a least one person to serve as Project Supervisor. This person shall be thoroughly familiar with the materials, equipment, and techniques of the planting operation, and shall be on site at all times to direct the Work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Planting schedule showing scheduled start and finish dates for each type of planting in each area of the site.
   2. Manufacturer’s specifications and installation instructions for all materials required.
3. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.

4. Qualifications Data: Submit qualifications data for the following:
   a. Landscape installer.
   b. Landscape supervisor.
   c. Testing agency.

5. Tag representative samples of each plant type to be installed for landscape architect's review at local suppliers.

B. Test Reports: Submit for approval the following:
   1. An analysis made by an approved laboratory stating the mechanical and chemical analysis of the peat humus proposed for use.
   2. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil as a component of planting soil mix.

C. Certificates: Submit for approval the following:
   1. Certificates of inspection as may be required to accompany shipments, and manufacturer's certified analysis for soil amendments and fertilizer materials.
   2. For standard products, submit other data certifying that materials comply with specified requirements.

D. Care and Maintenance Data: Submit the following:
   1. Report with instructions recommending procedures to be established by OWNER for full care, vigorous growth and maintenance of each type of plant specified, with specific recommendations for type of care, insect and disease prevention for each month of the year. Include color pictures of each type of plant used in the Project, showing full plant form and close-ups of leaf and flower forms, along with botanical and common names adjacent to written full care and maintenance recommendations.
      a. Submit report prepared in Microsoft Word or Adobe portable document format, with scanned pictures as specified, and provide OWNER with copies of compact disc.
   2. Submit prior to expiration of specified extended service periods.
   3. Provide underground irrigation system installer with suggested monthly watering schedule for establishment and maintenance of each type of planting shown on the Drawings. Watering schedule shall account for seasonal temperature change and its effect on each type of planting.

E. Warranty: Submit written warranty, signed by CONTRACTOR and landscape installer, as specified.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of exterior plants and in the installation of the types of materials required; 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 plants.
   c. Amount and kinds of exterior plants installed.

2. Installer’s Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-site during the time of preparation for, and planting of, exterior plants. Supervisor shall have achieved landscape or horticultural certification acceptable to the OWNER and ENGINEER.

3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to 1. Certified landscape supervisor shall be on-site throughout the day-to-day performance of the Work of this Section.

4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications and in accordance with each manufacturer’s instructions provided on each product label.

B. Soil-Testing Laboratory Qualifications:

1. An independent laboratory with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.

2. To qualify for approval, an independent testing agency shall demonstrate to ENGINEER’S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E 329 and as documented according to ASTM E 548, without delaying the Work.

C. Soil Analysis: Furnish report of soil analysis to ENGINEER, prepared by a qualified soil-testing laboratory, stating percentages of organic matter; mechanical gradation of sand, silt, and clay content in compliance with ASTM D 422; cation exchange capacity; sodium absorption ratio; deleterious materials content; pH; and mineral and plant-nutrient content of soil. Chemical analysis shall include tests for percentages of nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, iron, manganese, copper, zinc, extractable aluminum, and total soluble salts.

1. Existing On-Site Soil:
   a. Separate soil stockpiled and proposed for use as topsoil for planting soil mix into 1000 cubic yard piles and label with a numbering system used to reference all soil samples and test results.
   b. Obtain a one cubic foot representative sample for each 1000 cubic yards of soil stockpiled on-site proposed for use as topsoil for planting soil mix, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
c. Place samples taken from each stockpile, into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.

d. Take one cup of soil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.

e. Report suitability of soil as a topsoil component for plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micro-nutrients, potash and soil amendments to be added to produce satisfactory topsoils. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of soil.

f. In addition, all on-site soil that will be used as topsoil shall be provided with additional compost and peat moss amendments specified, whether or not testing indicates positive need for such amendments, for such material to be used as planting soil mix.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver each type of plant as the Work progresses, after preparations for planting that specific type of plant is completed, and when plants will be planted immediately upon arrival at the site. Do not stockpile plants on-site.

2. Deliver packaged materials in original, unopened containers, legibly showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery. Provide protective covering.

3. Do not drop plants during delivery.

4. Immediately remove unacceptable material from site.

B. Storage of Materials:
1. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist.

2. Set balled stock on ground and cover ball with soil, moistened peat moss or other acceptable material.

3. Heel-in bare root plants in a bed containing adequate peat moss to keep roots in a moist condition. Soak roots in water for two hours before planting.

4. Store and cover materials to prevent deterioration. Remove packaged materials that have become wet, or show deterioration or water marks, from site.

C. Handling of Materials:
1. Handle balled and burlapped plants so that the ball will not be loosened or broken. Immediately remove split, broken or loosened balled and burlapped material from site and replace with new material.

2. Do not remove container grown plants from containers until planting time.
3. Do not lift or drag plants by stems or trunks. Handle plants by lifting root ball or container.
4. Water as necessary to maintain plant root systems in a moist condition.

1.6 PROJECT CONDITIONS

A. Existing Conditions:
   1. Obstructions Below Ground and Utilities: Exercise extreme caution in all planting operations, as there are underground electric and telephone cables, sewer lines and water lines throughout the entire site. Study and be familiar with the location of these obstructions and underground utilities. Place plantings, where shown on the Drawings in the proximity of these obstructions and underground utilities, clear of any interference. Repair all damages to obstructions and underground utilities caused by the Work of this Section.

B. Environmental Requirements:
   1. Proceed with and complete the Work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of plant shown.
   2. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.
   3. Do not resort to chemical control measures at the first sign of insect or disease attack. Make an attempt to determine the environmental cause of the attack and take corrective measures.
   4. Apply chemical insect and disease measures locally and specifically to the area and type of planting in need of such insect and disease control, so as not to damage plantings, or endanger the environment. Select natural chemical controls specific to the type of insect or disease encountered, or provide naturally controlling insect predators and bacterial controls for release at the Site.
   5. Plantings exhibiting a broad and heavy infestation of insects or diseases, or where insects or diseases have disfigured plantings such that they no longer provide their intended aesthetic effect, shall be replaced with new plantings.

C. Scheduling:
   1. Coordinate planting with specified extended service periods to provide required service from date of acceptable completion of each type of planting. Plant during one of the following periods:
      a. Ocotillo may be planted year-round.
      b. Ornamental grasses should be planted between February and late April to allow establishment prior to the summer heat.
   2. Do not begin planting until water, acceptable for use and adequate in supply, is available on-site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project Schedule.
3. Do not proceed with installation of plants until all subgrade utility services have been installed, are operating successfully and have been approved by ENGINEER.
4. Plant only after final grades are established, unless otherwise acceptable to ENGINEER.

1.7 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate care and maintenance, or abuse by OWNER, or incidents that are beyond CONTRACTOR’S control.
   1. Warranty Period for Ocotillo: One year from date of end of extended service period.
   2. Warranty Period for Grasses: One year from date of end of extended service period.

1.8 EXTENDED SERVICE

A. Extended Landscape Service:
   1. Begin extended service immediately after each planted area, including Seeding and Decorative Stone Landscaping Work, is acceptably completed. Provide extended service for not less than the following periods:
      a. Ocotillo: Ninety days after plantings are acceptably completed.
      b. Grasses: Ninety days after plantings are acceptably completed.
   2. Prune, cultivate, water, weed, fertilize, shade, mist, restore planting saucers, tighten and repair stakes and guy supports, and reset plantings to proper grades or vertical position, as required to establish healthy, viable plantings.
      a. Do not allow plantings to wilt or show other signs of environmental stress.
      b. Provide landscape installer who shall be available on-call if notified between regular visits that plants require critical care or maintenance, throughout the time of extended service periods.
   3. Check and observe plantings for signs of insect and disease attack. Take corrective measures immediately upon notice of such attack. Control damaging insects and diseases, as specified.
   4. Restore or replace damaged tree wrappings.
   5. Remove dead plants immediately. Replace immediately unless required to plant in the succeeding planting season.
B. Provide water to ocotillo every 10 days from May to October, and every four weeks from November to April during the warranty period. Check soil between waterings. Soil around ocotillo should dry between waterings. If soil is still moist, do not water, checking soil every three days until soil has dried to a depth of 6 inches. Ocotillo roots may rot if overwatered.
   1. Apply water using a 1-inch diameter hose with an attached metering gauge for the first watering. Spray ocotillo canes during first watering thoroughly going around the entire plant.
   2. For subsequent waterings, apply water to the ground surface using the existing drip irrigation system. Apply water at a sufficiently slow rate to prevent water run-off from the soil surface but great enough to wet soil to the depth of the roots per the schedule above, adjusting for soil moisture conditions.

C. Any decline in the condition of plants shall require CONTRACTOR to take immediate action to identify potential problems and undertake corrective measures. If required, engage professional arborists or horticulturists to inspect plants, identify problems and recommend corrective procedures. Advise ENGINEER of all such actions and submit inspection and recommendation reports.

PART 2 - PRODUCTS

2.1 PLANTS

A. Plants shall mean any ocotillo or grasses required to be furnished for the project in accordance with Contract Documents. They shall be from a local source, grown in similar climatic conditions to the project site.

B. All plants shall be first class representative of their normal species or varieties. Unless otherwise specified, plants shall have average or normally developed branch systems and vigorous root systems. Plants shall be free from scale, disfigured knots, sun scale injuries, abrasions of the bark, rough/craggy bark, or other objectionable blemishes. Weak plants will not be accepted. Plants shall show appearance of normal health and vigor in strict accordance with the Contract Documents.

C. Tree sizes shall conform to the Arizona Nursery Association's recommended average tree specifications.

D. Plants with undeveloped, loose or broken rootballs will not be accepted.

E. Rootbound plants will not be accepted.

2.2 CHEMICAL FERTILIZER

A. Agriform fertilizer tablets at the following rates:
<table>
<thead>
<tr>
<th>Plant Size</th>
<th>No. of Tablets</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Gallon</td>
<td>3</td>
</tr>
</tbody>
</table>

B. Additional fertilizer/amendments, as recommended by CONTRACTOR’S soils laboratory.

2.3 MULCH

A. Mulch shall be per Drawings. It shall be free of any large clumps or other foreign material and shall be mixed evenly with all planting soil, as in accordance with the typical planting detail.

2.5 WEED-CONTROL BARRIERS

A. Nonwoven Fabric: Polypropylene or polyester fabric, 3-ounces per square yard, minimum.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to all Work of this Section, carefully inspect the installed Work of all other trades and verify that all such Work is complete to the point where this installation may commence. In addition, CONTRACTOR shall verify the location and depth below ground level of all utilities, footing, underground piping and conduit. All existing debris shall be removed from the site.

B. Verify that planting may be completed in accordance with the original design and the referenced standards.

C. All plants shall be in containers and placed in a cool area protected from sun and drying winds while in temporary storage prior to planting.

D. Planting areas shall not be cultivated when they are so dry as to cause excessive dust or so wet as to cause the formation of large clods.

E. Finish grade for these areas shall not vary more than 1-inch from the specified grade and cross-section and shall be smooth uniform surface, free of any abrupt grade changes or depressions. Unless otherwise specified, finish grade below adjacent paving, curbs, or headers shall be 2-inches.

3.2 PREPARATION
A. Protect structures, utilities, sidewalks, pavements, and other facilities and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual plant locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain ENGINEER’S acceptance of layout before planting. Make minor adjustments as required.

C. Lay out exterior plants at locations directed by ENGINEER. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation. Dispose of subsoil removed from pits and trenches in a legal manner, off-site.

1. Plant ocotillo and grasses in accordance with the Drawings.

B. Obstructions: Notify ENGINEER if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch diameter holes into free-draining strata or to a depth of ten feet, whichever is less, and backfill with free-draining material.

C. Drainage: Notify ENGINEER if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

D. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.4 PLANTING

A. Set plants plumb and in center of pit or trench with top of root ball set such that it will be 1-inch above adjacent finish grades, at plant stem, after planting soil mix has settled.

1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use plant if root ball is cracked or broken before or during planting operation.

2. Place planting soil mix around root ball in layers. Each layer shall not be more than 6-inch deep. Tamp to settle mix and eliminate voids and air pockets. Do not water-settle for ocotillo planting.
3. Remove all soil from around the root flare of the stem of each plant and from the top of the root ball to determine the true depth of the root flare. Plant with root flare at surface of finish planting soil mix.

B. Carefully remove root ball from container without damaging root ball or plant.
   1. After removal of plant from container, or sides from box, tease out feeder roots to assure positive contact and embedment into planting soil.

C. Perform complete sequence of planting steps for each plant within the same day.

F. Dish top of backfill to allow for mulching. Provide dish two feet in diameter approximately 2-inches deep around each ocotillo, with planting soil berm around edge of excavations to form shallow saucer to collect water.

G. After watering, any settlement within basins shall be refilled to required grade with planting soil mix.

3.5 BACKFILLING

A. Prepared backfill material shall consist of the following:
   1. 67 percent Soil.
   2. 33 percent clean sand.
   3. Agriform fertilizer tabs, for grasses only, as specified.
   4. Additional soil amendments as recommended by soils tests.

B. Sufficiently tamp backfill in 12-inch lifts to eliminate air pockets. Water plants per the previous recommendations.

3.6 ACCEPTANCE CRITERIA FOR PLANTS

A. Planting Work will be considered acceptable when:
   1. Ocotillo: When firmly planted, properly located and vertically upright, decorative rock, and saucers formed and in-place; with plant showing no signs of environmental stress, disease, insect infestations, mechanical damage or disfigurements such as broken canes, brittle dry canes or rot. Twigs and branches shall be tender and bendable, showing wet green tissue if tips are slightly bent.
   2. Grasses: When firmly planted, properly located and vertically upright, with decorative rock and saucers formed and in-place; with plant showing no signs of environmental stress, disease, insect infestations, damage or other disfigurement. Grass stems shall be flexible, not dry, evidence new blades and provide other indications of becoming vigorous, healthy growth.

3.10 CLEANUP AND PROTECTION
A. Protect plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and extended service periods. Treat, repair, or replace damaged exterior planting.

B. Protection includes all temporary fences, barriers and signs and other Work incidental to proper maintenance.

3.11 INSPECTION AND ACCEPTANCE

A. Where plants do not comply with specified acceptance criteria, replace plants and continue extended service period until plants comply with criteria for acceptance.

++ END OF SECTION ++
SECTION 02921

SEEDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all materials, equipment, labor, and incidentals required to furnish and install seeding of all areas shown on the Drawings or as directed by the ENGINEER.

B. Coordination:
   1. Review procedures described under other Sections and shall coordinate all Work required for seeding operation with that of other trades.

1.2 QUALITY ASSURANCE

A. Provide one person to serve as Project Supervisor. This person shall have a minimum of five years of experience in this specific type of Work and shall be thoroughly familiar with the materials, equipment and techniques of the seeding operation. This person shall be on site at all times to direct the Work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Documentation of experience in this type of Work, certificates indicating that the seed has been analyzed by a licensed seed laboratory, and product data sheets on fertilizer, mulch, and tackifying agent.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Do not deliver materials until site conditions are ready for the seeding, at which time the seed shall be delivered to the project site in standard sealed, undamaged containers. Each container shall be labeled in accordance with Arizona State Law and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Labels shall indicate the variety or strain of seed, the percentage of germination, purity and weed content. The date of analysis shall not be more than nine months prior to the delivery date.
2.1 CHEMICAL FERTILIZER

A. Fertilizer shall be composed of a mixture of one part sulfur-coated urea 25-4-8, one part monammonium phosphate 11-52-0, and one part methylene urea 38-0-0. The sulfur-coated urea, a blended fertilizer 25-4-8, shall have approximately 80 percent of the nitrogen defined as slow release, and contain 5 percent iron, 10 percent sulfur and trace amounts of zinc and manganese. The result shall be a 24-18-2 chemical blended fertilizer. Fertilizer and agricultural sulfur compounds shall be comprised of between 80 percent and 96 percent sulfur. Fertilizer shall be applied at a rate of 250 lbs/acre.

2.2 SEED

The species, variety and/or strain of seed (hereby referred to as contract-specified seed) shall be as shown on the project plans and as specified herein. Contract-specified seed shall be obtained from seed suppliers and/or collectors whose seed source can be documented to be from areas whose elevations are within 1,000 vertical feet of the project site.

Within 14 calendar days after the award of contract, the Contractor shall submit the name of the seeding subcontractor to be used, along with written confirmation from seed suppliers and collectors, on their letterhead, that the source(s) for the contract-specified seed has been secured. If any of the contract-specified seed is expected to be unavailable prior to the time specified for seeding, in accordance with Subsection 2.2.A – Seed Substitution below, the Contractor shall notify the ENGINEER and OWNER at this time.

### TABLE 02921-1

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>PLS Rate (Pounds Per Acre)</th>
<th>Per Pound Value for Substitution</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ambrosia deltoidea</em></td>
<td>Triangle-leaf Bursage</td>
<td>1.0</td>
<td>$10</td>
</tr>
<tr>
<td><em>Ambrosia dumosa</em></td>
<td>White Bursage</td>
<td>1.0</td>
<td>$25</td>
</tr>
<tr>
<td><em>Aristida purpurea</em></td>
<td>Purple Three-Awn</td>
<td>1.0</td>
<td>$25</td>
</tr>
<tr>
<td><em>Atriplex canescens</em></td>
<td>Fourwing Saltbush</td>
<td>1.0</td>
<td>$10</td>
</tr>
<tr>
<td><em>Baileya multiradiata</em></td>
<td>Desert Marigold</td>
<td>0.50</td>
<td>$60</td>
</tr>
<tr>
<td><em>Bouteloua aristidoides</em></td>
<td>Needle Grama</td>
<td>1.0</td>
<td>$15</td>
</tr>
<tr>
<td><em>Encelia farinosa</em></td>
<td>Brittlebush</td>
<td>2.0</td>
<td>$10</td>
</tr>
<tr>
<td>Plant Name</td>
<td>Common Name</td>
<td>Quantity</td>
<td>Cost</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td><em>Eschscholtzia mexicana</em></td>
<td>Mexican Poppy</td>
<td>1.0</td>
<td>$21</td>
</tr>
<tr>
<td><em>Lesquerella gordonii</em></td>
<td>Gordon’s Bladderpod</td>
<td>0.50</td>
<td>$30</td>
</tr>
<tr>
<td><em>Lupinus sparsiflorus</em></td>
<td>Desert Lupine</td>
<td>0.50</td>
<td>$65</td>
</tr>
<tr>
<td><em>Phacelia crenulata</em></td>
<td>Arizona Desert Bluebells</td>
<td>1.0</td>
<td>$32</td>
</tr>
<tr>
<td><em>Plantago ovata</em></td>
<td>Desert Indian Wheat</td>
<td>2.0</td>
<td>$2</td>
</tr>
<tr>
<td><em>Salvia columbariae</em></td>
<td>Desert Chia</td>
<td>0.50</td>
<td>$55</td>
</tr>
<tr>
<td><em>Senna covesii</em></td>
<td>Desert Senna</td>
<td>0.50</td>
<td>$30</td>
</tr>
<tr>
<td><em>Sphaeralcea ambigu</em></td>
<td>Desert Globemallow</td>
<td>0.50</td>
<td>$45</td>
</tr>
<tr>
<td><strong>Total PLS</strong></td>
<td></td>
<td><strong>14.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

The seed mix in Table 02921-1 is to be used in locations where hydroseed is called for on the project plans. This seed mix is also to be used in areas not indicated on the project plans where the Contractor must restore the site to meet permit requirements or as otherwise determined to require seed by the Engineer.

A) *Seed Substitution:*

No substitution of contract-specified seed will be allowed unless evidence is submitted documenting that the CONTRACTOR has made a diligent effort to obtain the contract-specified seed from seed suppliers or collectors, and that the contract-specified seed will not become available prior to the time specified for seeding in the CONTRACTOR’s construction schedule. The CONTRACTOR may also request a seed substitution if the lowest price available for the contract-specified seed is greater than 2.0 times the value shown in Table 02921-1 above.

The CONTRACTOR shall provide documentation of ‘non-availability’ or ‘prohibitive-cost’ from a minimum of three (3) seed suppliers or collectors supporting the request for substitution. Documentation shall include copies of invoices from each supplier or collector, indicating ‘non-availability’ and shall include a unit cost per PLS of the contract-specified seed in question as well as each alternate seed proposed for substitution. Only those invoices obtained at least three (3) weeks prior to the time specified for seeding in the CONTRACTOR’s construction schedule will be acceptable. CONTRACTOR shall use one or more seed suppliers or collectors in order to facilitate availability of seed at no additional cost to the OWNER.

Should a substitution of the contract-specified seed be requested as specified above and the CONTRACTOR’s documentation is approved by the OWNER, the ENGINEER will review and evaluate the alternate seed substitution request or specify an alternate seed(s) within seven (7) working days of the OWNER’s approval of the CONTRACTOR’s documentation. Alternate seed substitution requests shall be based on, but not limited to, the following factors: per pound replacement cost of the proposed substitution seed versus the cost of the contract-specified seed; seed application rates/quantities; project location, topography and project requirements, and any other factors that may impact the project.

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elevation; project stakeholder restrictions; and plant characteristics such as overall appearance, mature height, growth habit, soil requirements and occurrence within the known biological community. The CONTRACTOR’s seed substitution requests shall be developed in such a manner to equal the substitution value of the unavailable/cost-prohibitive seed, as indicated in Table 1. In the event that an adjustment of the application rate or a change in species composition of the seed mix, as required by the ENGINEER, is necessary in order to equal the substitution value of the unavailable/cost-prohibitive seed, this shall not be considered a change in the contract. Furthermore, in the event that the cost of a substituted seed, as approved by the ENGINEER, is not equal to or greater than the substitution value of the unavailable/cost-prohibitive contract-specified seed (as identified in Table 02921-1), the cost differential shall be deducted from the contract amount.

In the event that the CONTRACTOR’s request for substitution is denied and no alternate seed(s) has been specified, the ENGINEER may require that the contract-specified seed in question be removed from the seed mix(es), as listed in Table 02921-1 herein. For each pound of contract-specified seed not provided by the Contractor, the substitution value indicated in Table 02921-1 will be deducted from the contract amount.

No additional adjustments will be made for substituting an alternate seed, the costs being considered as included in the contract item for seeding.

No direct payment will be made for areas seeded with unapproved seed or the removal of unapproved seed and subsequent repair of these areas.

2.3 MULCH

A. Wood fiber mulch shall consist of a specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch shall be from virgin wood and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry. The mulch shall be applied at the rate of 2,000 pounds per acre.

2.4 TACKING AGENT

A. Tackifier shall be a free flowing, non-corrosive powder produced from natural plant gum of Plantago insularis (Indian Wheat), and shall be applied at the rate of 100 pounds per acre.

PART 3 - EXECUTION

3.1 GENERAL

A. Seeding operation shall commence upon completion and the ENGINEER’S acceptance of Work in all other Sections.
3.2 APPLICATION

A. Upon direction from the ENGINEER, broadcast soil conditioner and fertilizers to all areas to receive the contract specified seed to the satisfaction of the ENGINEER.

B. Areas to be seeded shall be prepared with a ripper bar, chisel plow or other equipment capable of providing thorough soil cultivation to a minimum depth of 4 inches. Furrows from tillage shall be no more than 12 inches apart. Existing vegetation not indicated to be removed in the Drawings or per these Specs shall be protected or crushed in place prior to seeding with the roots left in place and intact, and the soil shall be left in a friable, roughened condition. Remove and dispose of all sticks, roots, rubbish, and other deleterious material. Exposed material larger than four (4) inches shall be removed and disposed of in an approved manner prior to seeding. Native rock material, which does not interfere with seeding operations, may remain on ground surface, as approved by the ENGINEER. Finish grade and surface appearance shall attempt to match finish and texture of natural desert areas. The ENGINEER shall approve areas following soil preparation and prior to hydroseed application.

C. Except as specified herein, slopes shall be constructed in accordance with 02315 – Structural Excavation and Backfill. On slope areas, tillage shall be directional along the contours of the areas involved. All areas which are eroded shall be restored to the specified condition, grade, and slope prior to seeding, as directed by the ENGINEER. For areas too steep to be prepared for seeding after the slope has been completed, tillage shall be accomplished with appropriate equipment as the slope is being constructed, per direction of the ENGINEER. Compacted, hardened soil surfaces will not be accepted for seed application.

B. Upon acceptance of soil preparation, broadcast a slurry containing water, seed mix, mulch, and tacking agent at the specified rates over the entire area to be seeded, as directed by the ENGINEER.

C. Care shall be taken during the seeding operation to prevent damage to existing shrub roots in the seeding area.

D. Slurry material which is placed upon buildings, treatment facilities, roadways, trees, or any area where seeding is not specified shall be removed as directed by the ENGINEER.

3.3 MAINTENANCE

A. Maintain the Work performed in this Section for a period of 120 days keeping the area free from weeds and repairing eroded areas.

B. Any areas that do not show evidence of germination at the end of 12 months, shall be reseeded by CONTRACTOR, at no additional cost to the OWNER.

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SECTION 03305

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 concrete, reinforcement, and related materials.
   2. The Work includes:
      a. Providing pneumatically placed shotcrete in accordance with the Drawings, these specifications and MAG Standard Specifications Section 525.

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 all concrete, unless indicated otherwise.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
   1. Concrete Testing Service:
      a. Employ acceptable testing laboratory to perform materials evaluation, testing, and design of concrete mixes.
      b. OWNER will employ a separate testing laboratory to perform field quality control sampling and testing on concrete delivered to and placed at the site. Full access shall be provided by CONTRACTOR to personnel of OWNER’S testing laboratory to Work and shall provide all assistance, including labor and equipment, necessary to facilitate testing and sampling.
   2. Certificates, signed by concrete producer and CONTRACTOR, may be submitted in lieu of material testing when acceptable to ENGINEER.
   3. OWNER'S testing laboratory will perform field quality control sampling and testing during concrete placement, as follows:
      b. Slump: ASTM C 143, one test for each load at point of discharge.
      c. Air Content: ASTM C 231.
      d. Compressive Strength: ASTM C 39, one set of compression strength specimens for each 50 cubic yards or fraction thereof or for each 2,500 square feet of surface area or fraction thereof for each class of concrete placed in any one day.
1) Test one specimen at seven days and two specimens at 28 days.
2) When the total quantity of concrete is less than 50 cubic yards, the strength tests may be waived by ENGINEER following review and acceptance of submitted field experience indicating evidence of satisfactory strength.
3) Slump and air content testing shall be conducted on each sample from which compressive strength specimens are taken.
4) Report test results in writing to ENGINEER on same day tests are made.

B. Standard Specifications and Details:
1. Conform to all applicable requirements of Sections Nos. 505, 525, 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.

C. Reference Standards: Comply with applicable provisions and recommendations of the latest editions of the following, except as otherwise shown or specified.
1. ACI 224, Control of Cracking in Concrete Structures.
2. ACI 301, Specifications for Structural Concrete.
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 315, Details and Detailing of Concrete Reinforcement.
8. ACI 318, Building Code Requirements for Structural Concrete.
9. ACI 347, Guide to Formwork for Concrete.
11. ASTM A 82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
12. ASTM A 185, Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
13. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
14. ASTM A 615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
15. ASTM C 33, Specification for Concrete Aggregates.
20. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.
21. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
23. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
27. ASTM D 1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. ASTM E 154, Test Method for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

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. Submit the following Shop Drawings:
   1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
   2. Concrete placement plans showing the location and type of all joints.
   4. 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 in accordance with ACI 301, Section 4. Submit written report to ENGINEER for each proposed concrete mix at least 15 days prior to start of Work. Do not begin concrete production until mixes have been reviewed and are acceptable to ENGINEER. Mix designs may be adjusted when material characteristics, job conditions, weather, test results, or other circumstances warrant. Do not use revised concrete mixes until submitted to and accepted by ENGINEER.

A. 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.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

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.
B. 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.

C. Store concrete reinforcement materials to prevent damage and accumulation of foreign material including dirt and excessive rust. Store on framework or blocking such that no materials come in contact with ground. Space framework or blocking supports to prevent excessive deformation of stored materials.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II.

B. Aggregates: ASTM C 33.
   1. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank run sand, and manufactured sand are not acceptable.
   2. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
      a. Crushed stone, processed from natural rock or stone.
      b. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.

C. Coarse Aggregate Size: ASTM C 33, Nos. 57 or 67, unless permitted otherwise by ENGINEER.

D. Water: Clean, potable.


F. Water-Reducing Admixture: ASTM C 494, Type A. Only admixtures which have been tested and accepted in mix designs shall be used.

G. Water Reducing and Set Adjusting Admixtures: ASTM C 494, Type D and E. Only admixtures which have been tested and accepted in mix designs shall be used.

H. High Range Water-Reducing Admixture: ASTM C 494, Type F/G. Only admixtures which have been tested and accepted in mix designs shall be used.

I. Calcium Chloride or admixtures containing chloride ions shall not be used.
2.2 CONCRETE MIX

A. General
   1. Normal weight: 145 pounds per cubic foot.
   2. Use air-entraining admixture in all concrete: provide not less than four percent nor more than eight percent entrained air for concrete exposed to freezing and thawing, and from three percent to five percent for other concrete.

B. Proportioning and Design of Type “1” Mix:
   1. Minimum compressive strength at 28 days: 4,000 psi.
   2. Maximum water cement ratio by weight: 0.45.
   3. Minimum cement content: 564 pounds per cubic yard.

C. Slump Limits:
   1. Proportion and design mixes to result in concrete slump at the point of placement of not less than 1-inch and not more than 4-inches.
   2. Where high range water reducers are used, slump prior to addition of admixture shall not exceed 3-inches. Slump after addition of admixture shall not exceed 8-inches at point of placement.

D. Adjustment to Concrete Mixes:
   1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, job conditions, weather, test results, or other similar circumstances.
   2. Laboratory test data for adjusted concrete mix designs, including compressive strength test results, shall be submitted to ENGINEER for review.
   3. Adjusted mix designs shall be implemented only with the approval of the ENGINEER.
   4. Adjustments to the concrete mix designs shall result in no additional costs to the OWNER.

2.3 REINFORCING MATERIALS

A. Welded Wire Fabric: Per MAG Standard Spec Sections 525.4 and 727.

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 FORMWORK

A. Forms shall be in accordance with MAG 525.7.

3.3 REINFORCEMENT, JOINTS, AND EMBEDDED ITEMS

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 support.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice and other materials which act to reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement. Locate and support reinforcing by means of 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 with ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Reinforcement shall not be secured to formwork with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

D. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcement more than 2-inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

E. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

F. Install welded wire fabric in as long lengths as practical, lapping adjoining sections a minimum of one mesh.

G. Concrete shall not be placed until the reinforcement is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected. Notify ENGINEER a minimum of two working days prior to proposed concrete placement.

H. Joints:
   1. Provide joints per MAG Standard Spec Section 525.8.

3.4 CONCRETE PLACEMENT

EPG Project No. COP 0009 03305-6 2/28/2014
A. Job-Site Mixing: Use drum type batch machine mixer, mixing not less than 1-1/2 minutes for one cubic yard or smaller capacity. Increase mixing time a minimum of 15 seconds for each additional cubic yard or fraction thereof.

B. Ready-Mixed Concrete: Comply with the requirements of ASTM C 94.

C. Concrete Placement:
   1. Place concrete in a continuous operation in accordance with MAG Standard Spec Section 525 and other related specification sections.

3.5 QUALITY OF CONCRETE WORK

A. Make all concrete solid, compact, smooth and free of laitance, cracks and cold joints.

B. All concrete for liquid retaining structures, and all concrete in contact with earth, water or exposed directly to the elements shall be watertight.

C. 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. Patches or plastering will not be acceptable.

D. Repair, removal and replacement of defective concrete as ordered by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

A. Curing shall be accomplished in accordance with MAG Standard Spec Section 525.10.

3.7 FINISHES

A. Slab Finish:
   1. Shotcrete or “gunite” shall have an integral color to match adjacent existing. CONTRACTOR to provide a 2’x2’ mock-up of gunite finish color for ENGINEER approval prior to beginning work under this section.

++ 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 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 C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
   6. ASTM D 903, 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>C 109</td>
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<tr>
<td>at 1 day</td>
<td>2000 psi</td>
<td></td>
</tr>
<tr>
<td>at 28 days</td>
<td>6000 psi</td>
<td></td>
</tr>
<tr>
<td>Bond Strength (minimum)</td>
<td></td>
<td>C 882*</td>
</tr>
<tr>
<td>at 28 days</td>
<td>1800 psi</td>
<td></td>
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</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 anaromatic 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, unrepaired 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 C 109. 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 ++
LANDSCAPE IRRIGATION SYSTEM REPAIR AND REPLACEMENT

441.1 DESCRIPTION:
The Contractor shall furnish all the necessary labor, materials, and equipment required to complete the repair and restoration of the existing automatic sprinkler irrigation system providing full coverage to all plants and shrubs.

441.2 GENERAL:
The Contractor shall coordinate with the 24th Street Reservoir facilities supervisor prior to confirming the equipment requirements and operations prior to beginning work (Contact: Adam Zendajas, (p) 602.262.4983, (c) 602.722.5184). Preliminary adjustments to conform to actual site condition shall be accomplished at this time and the approval of the Engineer obtained prior to any actual work being performed. Utility connections, both water and electrical, are existing.

Prior to final inspection, the Contractor shall submit one set of corrected, as-built drawings showing the location of work.

All permits for installation or construction of any of the work included under this section, which are required by legally constituted authorities having jurisdiction, shall be obtained and paid for by the Contractor, each at the proper time. He shall also arrange for and pay all costs in connection with any inspections and examinations required by these authorities.

441.3 MATERIALS:
Prior to the start of construction, the Contractor shall submit shop drawings on all material for approval of the Engineer.

The Manufacturer of component equipment specified in the Special Provisions or existing to be replaced in type and kind form the basis of the irrigation design as well as the physical and operational standards for which the components were selected. Component equipment from other manufacturers may be submitted, by the Contractor, to the Engineer for approval. No equipment however is to be ordered without approved shop drawings.

Subsection 441.3.1 Plastic Pipe
Rigid Plastic Pipe shall be extruded from 100% virgin normal impact unplasticized polyvinyl chloride (PVC) Type I, Grade I or II resin 2000 psi (PVC 1120 or PVC 1220), design stress ASTM D1784, Department of Commerce PS-21-70, PS-22-70, Standard Dimension Ratio (SDR) 26 or less than 160 psi. Pipe shall conform to ASTM D-2241 and D-2672.

Testing of pipe:
Provide written certificate by supplier that polyvinyl chloride pipe has successfully passed the following tests:

Acetone test: Immerse a sample of pipe in 99% pure anhydrous acetone for 15 minutes; at the end of this time there should be no evidence of flaking or
delamination on the inner or outer walls of pipe. Evidence of softening or swelling shall not constitute failure.

Flattening: Cut a specimen two inches long from each end of the pipe sample. Flatten each test specimen from parallel plates of a press until the distance between the plates, in inches, is equal to sixty (60) percent of the pipe O.D., and there shall be no evidence of cracking, splitting or breaking.

The pipe shall be homogeneous throughout, free from visible cracks, holes, or foreign materials. The pipe shall be free from blisters, dents, wrinkles or ripples and die and head marks. Piping up to and including 2-1/2" size shall be SDR solvent welded. Pressure mainline piping 3" size and larger shall be gasket pocket type, as manufactured by the Swanson Co. or approved equal, and shall conform to ASTM F-477.

Continuously and permanently mark pipe with manufacturer's name or trademark, kind and size (IPS) of pipe, material, manufacturer's lot number, schedule or type and NSF seal of approval.

Subsection 441.3.2 Pipe Fittings and Couplings

For pipe fittings up to and including 2-1/2" size, fittings and couplings shall be either threaded type or slip fitting tapered socket solvent weld type. Schedule 80 pipe will only be used for threaded joints. Tapered socket solvent weld fittings may be either Schedule 80 or Schedule 40, but in either case, will be equal to or greater than the schedule and Pressure Rating of the plastic pipe being joined. Tapered fittings shall be sized so that a dry, unsoftened taper cannot be inserted more than halfway into the socket. Plastic saddles and flange fittings are not permitted. PVC fittings shall be marked with manufacturers name or trademark, type PVC, size and NSF seal of approval. Extruded couplings to be produced from NSF rated raw materials and meet ASTM standards. For pipe 3" and greater, fittings shall be ductile iron, grade 80-55-06, in accordance with ASTM A-536. Fittings shall have mechanical joints with gaskets meeting ASTM F-477. Fittings shall have radii of curvature conforming to AWWA C110.

Subsection 441.3.3 PVC Primer

The primer shall be specifically formulated for the pipe and type of connection, as recommended by the pipe manufacturer.

Subsection 441.3.4 Emitters

Emitters to match existing and as described in the Manufacturer's latest literature (Catalogue cut sheets) constitute the performance and quality standards for this equipment.

441.4 LANDSCAPE IRRIGATION SYSTEM REMOVAL AND RESTORATION:
The Contractor shall remove and cap the portion of the existing irrigation system within planter boxes as necessary to perform the tree removal and other work indicated on the plans.
and as approved by the ENGINEER, whether shown or not shown on the plans. If the removals affect other areas of the system not in conflict with the construction, the Contractor shall permanently or temporarily restore or modify the existing system to provide water to the unaffected areas.

The Contractor shall restore the affected landscape irrigation system to an operational condition equal to or better than the existing system. Emitters shall be installed to each new Ocotillo and decorative grasses per the following schedule:

Ocotillo (*Fouquieria splendens*) – (1) 1-gallon per hour emitter, each
Pink Muhly (*Muhlenbergia capillaris*) – (2) 1-gallon per hour emitters, each

The Contractor shall have the option to salvage and reuse existing materials. In the event that it is not feasible to reinstall the salvaged materials, new materials shall be installed.

**441.5 TRENCH EXCAVATION AND BACKFILL:**
Trenches and other excavations shall be sized to accommodate the irrigation system components, conduit, and other required facilities. Additional space shall be provided to assure proper installation and access for inspection. Unless otherwise specified, the minimum depth of cover over pipelines and conduits shall be as follows:

(A) Electrical conduit - 18 inches  
(B) Waterlines continuously pressurized - 18 inches  
(C) Lateral sprinkler lines - 12 inches  
(D) Plastic lines under pavement - 24 inches

The bottom of trenches shall be true to grade and free of protruding stones, roots or other matter which would prevent proper bedding of pipe or other facilities.

Trenches and excavations shall be backfilled so that the specified thickness of topsoil is restored to the upper part of the trench. Compaction shall be in accordance with Section 301.

Water settling of trench backfill will not be permitted unless approved by the Engineer.

**441.6 PIPE INSTALLATION:**
(A) General: Pipe fittings shall be installed in accordance with the manufacturer's recommendations and these specifications. When requested by the Engineer, the Contractor shall furnish the manufacturer's printed installation instructions before pipe installation.

Plastic pipe shall be cut square, externally chamfered approximately 10-15 degrees, and all burrs and fins removed. It shall be joined utilizing threaded fittings or socket type, solvent welded fittings. Schedule 80 pipe only will be used for threaded joints. Field threading will be accomplished in the same manner as specified for steel pipe, except that a plug will be installed in the bore of the pipe prior to threading to prevent distortion. Threaded pipe joints shall be made using teflon tape on the male threads. Solvent will not be used for threaded joints. Threaded joints shall be hand tightened with final tightening as necessary to prevent
leaks with a strap wrench. Solvent welded joints shall be made in accordance with ASTM D2855, and the type of solvent recommended by the pipe manufacturer shall be used. Solvent shall be applied to the pipe ends in such a manner that no material is deposited on the interior surface or forced into the interior of the pipe during insertion. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.

The pipe shall be protected from damage during assembly. All vises shall have padded jaws and only strap wrenches shall be used. Any plastic pipe which has been nicked, scarred, or otherwise damaged shall be removed and replaced. Care shall be exercised so that stresses on the previously made joints are avoided. Movement of the pipe following assembly, such as lowering the pipe into the trench, shall not occur prior to the set time recommended by the manufacturer of the solvent cement used.

The pipe will not be exposed to water for at least 12 hours after the last solvent welded joint has been made.

441.7 AUTOMATIC CONTROL SYSTEM:
The Contractor shall maintain connection to the existing valves and automatic irrigation controller. The Contractor shall coordinate with the facilities supervisor to access the controller for operational stoppages, testing, and other necessary functions of the systems.

441.8 FLUSHING AND TESTING:
After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove all foreign material. After flushing, the following tests shall be conducted in the sequence listed below. All equipment, materials, and labor necessary to perform the tests shall be furnished by the Contractor and all tests shall be conducted in the presence of the Engineer.

Operational Test: The performance of all components of the automatic control system shall be evaluated for manual and automatic operation.

During the maintenance period specified and at least 9 days prior to final acceptance, the Contractor shall set the controller on automatic operation and the system shall operate satisfactorily during this period. All necessary repairs, replacement and adjustment shall be made until all equipment, electrical work, controls and instrumentation are functioning in accordance with the contract documents.

441.9 MEASUREMENT AND PAYMENT:
Measurement and payment shall be in accordance with Section 01271. The lump sum prices established in the proposal sheets shall be full compensation for furnishing all labor, materials, tools and equipment, and performing all work necessary to complete the work described or specified in the contract.

++ END OF SECTION ++